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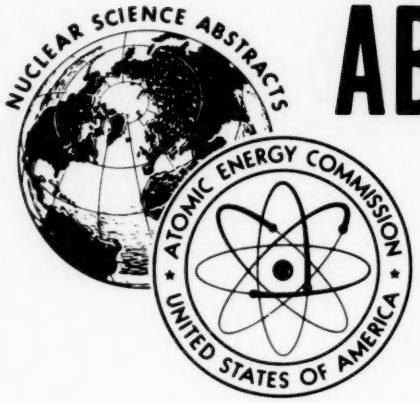

Volume 26 Number 12

Abstracts 27728-30618

June 30, 1972

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NOTICE

A title page for Volume 26, Numbers 7–12, is included at the back of this issue for use in binding those issues.

CORRECTIONS

NSA Vol. 26, No. 1, Abst. 268, line 1 should read: FRENCH PROJECT FOR A EUROPEAN INSTALLATION FOR ENRICHMENT OF URANIUM.

NSA Vol. 26, No. 1, Abst. 268 should read: The French plans for a gaseous enrichment plant for uranium for CEA are discussed. Operating conditions which are economically and technically feasible are outlined. The French estimate of enrichment costs, including power, maintenance, amortization and taxes, was $28.5/kg of uranium. (K.S.W.)

NSA Vol. 26, No. 4, Abst. 7044, line 2 should read: RAT EMBRYOS BY DEMETHYLCHLOROTETRACYCLINE

NSA Vol. 26, No. 4, Abst. 7044, line 6 should read: Experiments have revealed demethyl-chloro-tetracycline

NSA Vol. 26, No. 5, Abst. No. 9872, line 3 should read: TION OF IODIDE ZIRCONIUM. Fedorov, G. B.; Kussil, A. E.;

NSA Vol. 26, No. 5, Abst. No. 9872, line 7 should read: friction of iodide zirconium were studied. The existence of stable complexes

NSA Vol. 26, No. 5, Abst. No. 9872, line 12 should read: ing of iodide zirconium with 0.6% oxygen raised the modulus of elasticity over

NSA Vol. 26, No. 6, Abst. No. 11775, should read: The rate constant of the reaction of the TcO_4^- ion with hydrated electrons was found to be $1.15 \pm 0.1 \times 10^{10}$ lm^{-1} sec^{-1}. The electrons were produced by photogeneration in order to suppress other reactions. (M.C.G.)

NSA Vol. 26, No. 7, page 1609, the line under subcategory caption "MOESSBAUER EFFECTS AND NMR" should read: Refer also to abstracts, 14983, 15364 and 16456.

NSA Vol. 26, No. 9, Abst. 19930, line 2 should read: MATERIALS BY HIGH-ENERGY GAMMA — PHOTON ACTIVATION.

Volume 26, Number 12, June 30, 1972

NUCLEAR SCIENCE ABSTRACTS

A semimonthly publication of the USAEC Office of Information Services, John A. Harris, Director. Published by the USAEC Technical Information Center, Robert L. Shannon, Manager.

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NEWCOMB, William A., Stability of a magnetic well,  25:1239
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    alloys V3Si--Nb3Al,  25:1093 (CALT-822-13)
NEWLAND, E. A., Radiation treatment of sewage,  25:140
    (AAEC/LIB/81b-254)
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```
TRANSURANIUM ELEMENTS
  determination in bone ash, radiochemical method for,
    25:40 (IDO-12073, pp 28-36)
  separation by ion exchange and complex-formation elution,
    25:251(P)
TRIETHYLENETETRAMINE
  complexes with cobalt(III) and rhodium(III) chlorides,
    radiation effects on labeled, thermal-neutron,  25:137
TRITIUM
  content in Cattaraugus Creek near West Valley Processing
    Plant, July through Dec. 1969,  25:258 (DOCKET-50201-
    48)
  content in Cattaraugus Creek near West Valley Processing
    Plant, Jan. to July 1970,  25:259 (DOCKET-50201-49)
  determination in luminescent material by scintillation
    counting,  25:40 (IDO-12073, pp 28-36)
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372 (UCRL-72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. Griffith, R. V.; Anderson, A. L.; Lindeken, C. L. (California Univ., Livermore. Lawrence Radiation Lab.). Oct 1970. 27p. (CONF-701009–1). Dep. NTIS.

is indexed as:

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CALIFORNIA UNIV., LIVERMORE.  LAWRENCE RADIATION LAB.
  Construction of a unique underground whole body counter,
    25:372 (UCRL-72739)
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Volume 26, Number 12, June 30, 1972

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

27728 (AEC-tr-7223/1-2) NUKLEONIKA. Translation of Nukleonika; 16: No. 1-2, 1-96(1971). 84p. (TT-70-55104/1-2). Dep. NTIS.

27729 (BLG-460) ANNUAL SCIENTIFIC REPORT, 1970. Billiau, R.; Buyse, L.; de Coster, M.; Fredrix, H. (eds.) (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 246p. Dep. NTIS (U. S. Sales Only).

Abstracts are presented that report results of research during 1970 in the fields of nuclear physics, solid-state physics, radiobiology, and the development of power and research reactors. Separate abstracts were prepared on 13 sections of the report. (C.H.)

For abstracts of individual sections see: 27730, 27962, 27964, 27965, 28033, 28440, 28537, 29665, 30090, 30166, 30167, 30408, and 30409.

Analytical Chemistry

Refer also to abstracts 28023, 28228, 28609, and 28678.

27730 (BLG-460, pp 8.1-8) SCIENTIFIC SUPPORT. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 1970. In Annual scientific report, 1970.

27731 ORGANIC REAGENT RESEARCH AT THE ANALYTICAL CHEMISTRY DEPARTMENT OF THE CHEMICAL TECHNOLOGY INSTITUTE IN PRAGUE. Holzbecher, Zavis (Vysoka Skola Chemicko-Technologicka, Prague). Chem. Listy; 66: No. 1, 7-20(Jan 1972). (In Czech).

Organic reagents used in analytical chemistry, from 1925 to the present, at the Chemical Technology Institute in Prague are reviewed (144 references, mostly Czechoslovakian). These reagents include diketone, phenylfluorone, and salicylaldehyde derivatives as well as selective ion exchange resins for separation. Of about 100 such reagents studied, 23 were not previously described in the literature. The compositions of 200 metal complexes and their properties were established, and 70 methods for microdetermination and separation were developed. Sensitivities are, in most cases, as low as 1 ng. Techniques include fluorescence, fluorimetry, gravimetry, paper chromatography, extraction, and spectrophotometry. (TTT)

27732 AUTOMATIC WATER VAPOR SAMPLER FOR STABLE ISOTOPE INVESTIGATIONS. Zimmermann, U. (Univ., Heidelberg). Int. J. Appl. Radiat. Isotop.; 23: No. 4, 173-7(Apr 1972).

An automatic water vapor sampler and its applicability for stable isotopic investigations is described. It is shown that the apparatus is suitable for stable isotope investigations when the working conditions are properly chosen. (auth)

27733 CONTRIBUTION TO THE THEORY OF INTERCOMPARISON RUNS. Mahling, A. (Landesanstalt fuer Lebensmittel-, Arzneimittel- und Gerichtliche Chemie, Berlin). pp 825-39 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

Intercomparison runs are made to establish whether different laboratories obtain the same measured results for identical samples. Each measured result is an accidental quantity, and the probability that the participants in an intercomparison run obtain identical results converges to zero. It is therefore difficult to evaluate whether the results of the participants differ only by accident or if significant differences exist between their measured values. To answer this question, the conception of reproducibility is defined quantitatively. Intercomparison runs for the determination of the reproducibility are proposed. If the participants in such an intercomparison run perform routine measurements on different samples of the same kind, a comparison of the reproducibilities can be made also without sample dispatch. If the reproducibilities are in accordance, intercomparison runs by dispatch of identical samples can be used to standardize the evaluations of the different laboratories, so that the measured results are identical within an arbitrarily given accuracy. If the reproducibilities of different laboratories do not agree, the accuracy is given by the scattering of the systematic error of the different laboratories. In this case, the measured values of a method are to be examined as to whether they can be normalized, i.e., whether they correspond to a definable distribution. (auth)

27734 AUTOMIZATION OF ANALYTICAL METHODS. Clements, J. A. (Technicon GmbH, Frankfurt am Main). pp 915-28 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

The basic principles of continuous flow analysis are described as is the necessary equipment for carrying out this type of analysis. The further development of this basic equipment is described as well as the development of multiple analysers for clinical applications. Its application to radiochemical analysis is discussed. (auth)

Activation and Nuclear Reaction Procedures

Refer also to abstract 29707.

27735 (BNL-16658) NEUTRON SOURCES, ENERGY, FLUX DENSITY, AND MODERATION IN TOTAL-BODY NEUTRON ACTIVATION ANALYSIS. Cohn, S. H.; Fairchild, R. G.; Shukla, K. K. (Brookhaven National Lab., Upton, N. Y.). [1972]. 22p. (CONF-720411-1). Dep. NTIS.

From Symposium on dosimetry techniques applied to agriculture, industry, biology, and medicine; Vienna, Austria (17 Apr 1972).

The factors involved in achieving uniform irradiation of the target element in human subjects and the radiation dose received by the patient, as related to those factors, are considered. The factors include: neutron sources, energy, flux density distribution, and moderators. (M.C.G.)

27736 (BNL-16659) COMPARISON OF TECHNIQUES FOR THE TOTAL-BODY NEUTRON ACTIVATION ANALYSIS OF CALCIUM IN MAN. Cohn, S. H.; Fairchild, R. G.; Shukla, K. K. (Brookhaven National Lab., Upton, N. Y.). [1972]. 22p. (CONF-720411-2). Dep. NTIS.

From Symposium on dosimetry techniques applied to agriculture, industry, biology, and medicine; Vienna, Austria (17 Apr 1972).

The $^{48}Ca(n,\gamma)^{49}Ca$ reaction of partially moderated 14-MeV neutrons was used along with a bi-lateral exposure in three techniques developed for measuring whole-body calcium in man. A uniform thermal neutron distribution through the body and uniform counting sensitivity of a whole-body counter are essential. (M.C.G.)

27737 (EUR–4778) DETERMINATION OF THE ^{235}U, ^{239}Pu, AND ^{240}Pu CONTENTS IN MIXED FISSILE MATERIALS BY MEANS OF ACTIVE AND PASSIVE NEUTRON TECHNIQUES. Birkhoff, G.; Bondar, L.; Ley, J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1972. 30p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 50.–.

The feasibility of determining ^{235}U and ^{239}Pu contents in mixed fuel by measuring prompt and delayed fission neutron yields obtained in a sub-MeV neutron flux was investigated. This method is combined with the classical correlation technique for measuring the spontaneous fission neutrons of ^{240}Pu. Problems related to the control of fissile material contents in reactor fuel are emphasized. A layout study and a description of an apparatus for measurements with fast breeder fuel pins are included. In the case of a RAPSODIE fuel pin the accuracies of a single measurement within 15 min are estimated to be about 1, 2, and 3% for ^{235}U, ^{239}Pu, and ^{240}Pu, respectively. (auth)

27738 (INR-P–1359) DETERMINATION OF FISSION PRODUCT ^{148}Nd FOR BURN-UP. Zelenay, Tadeusz (Institute of Nuclear Research, Warsaw (Poland)). 1971. 10p. (CONF-700540–5). Dep. NTIS (U. S. Sales Only).

From Polish-Italian seminar on some chemical, ceramic, and metallurgical aspects of nuclear fuels; Zakopane, Poland (29 May 1970).

^{148}Nd was separated from irradiated fuel by static and column extractions. The ^{148}Nd content could be determined by coirradiating known amounts of ^{148}Nd with the separated neodymium fraction and investigating the ^{148}Nd spectra. (auth)

27739 (ITE–62–F) NONDESTRUCTIVE ANALYSIS OF MEDIEVAL GOLD COINS. Kowalski, H.; Reimers, P. (European Communities, Brussels (Belgium). Commission). 1971. 23p. (In French). (CONF-711132–2). Dep. NTIS (U. S. Sales Only).

From Symposium on nuclear analysis techniques in the production and industrial use of noble metals; Brussels, Belgium (16 Nov 1971).

Various gold coins of the period 1231 to 1284 were analyzed by fast neutron (14 MeV) activation and γ spectrometry for Cu and Ag content, which ranged from 0.2 to 35%. The coins were irradiated for 40 sec with a neutron flux of 10^9 n cm^{-2} sec^{-1}. Possible interferences are considered. Results are compared with those from x fluorescence analysis. (J.G.B.)

27740 (ITE–63–F) NEUTRON-ACTIVATION DETERMINATION OF TRACES OF GOLD, IRIDIUM, COPPER, AND MANGANESE IN GAUZES OF PLATINUM AND PLATINUM–RHODIUM. Verot, J.; Jaumier, J. (European Communities, Brussels (Belgium). Commission). 1971. 11p. (In French). (CONF-711132–5). Dep. NTIS (U. S. Sales Only).

From Symposium on nuclear analysis techniques in the production and industrial use of noble metals; Brussels, Belgium (16 Nov 1971).

A neutron activation method was developed for rapid control of the Au, Ir, [illegible] and Mn content of platinum and platinum–rhodium gauzes. Reactor-produced neutrons and γ spectrometry were used. Results are compared with those achieved by chemical methods. Accuracy and precision of the method are considered adequate for routine control of impurities. (J.G.B.)

27741 (ITE–65–D) ANALYTICAL INVESTIGATION OF THIN NOBLE METAL LAYERS FOR THEIR GAS CONTENT WITH HELP OF NEUTRON ACTIVATION. Mueller, G. F. P. (European Communities, Brussels (Belgium). Commission). 1971. 7p. (In German). (CONF-711132–3). Dep. NTIS (U. S. Sales Only).

From Symposium on nuclear analysis techniques in the production and industrial use of noble metals; Brussels, Belgium (16 Nov 1971).

Activation analysis represents a useful tool for the analysis of gases deposited in thin layers of noble metals. Oxygen and nitrogen can be determined with fast high-energy neutrons. Argon can be measured through activation with slow neutrons. The method is demonstrated on several examples. (tr-auth)

27742 (ITE–66–E) POSSIBILITIES FOR THE APPLICATION OF NEUTRON ACTIVATION ANALYSIS. Gijbels, R.; Hoste, J. (European Communities, Brussels (Belgium). Commission). 1971. 108p. (CONF-711132–1). Dep. NTIS (U. S. Sales Only).

From Symposium on nuclear analysis techniques in the production and industrial use of noble metals; Brussels, Belgium (16 Nov 1971).

Some advantages and limitations of neutron activation analyses are discussed with special reference to the field of the noble metals. Metallurgical, industrial and geochemical applications are reviewed. Because of the limited sensitivity, accelerator-produced 14-MeV and 2.8-MeV neutrons do not seem to be promising for neutron activation determinations of the noble metals. Thermalized 2.8-MeV neutrons are, however, potentially useful for surface exploration of Ag in ores with contents above 10 ppM. Fast Ag determinations in ores and dressing products can be achieved by a resonance absorption method for similar concentrations, using a neutron generator with an output of 10^9n/sec. Reactor thermal neutron activation is of great practical importance, because of its very great sensitivity. Without preconcentrations, it is possible to determine Ru, Ag, Os, and especially Pd, Ir, and Au at the sub-ppB level ($<10^{-7}$%) in 1 g samples, after radiochemical separations. Ir, for instance, was measured in rocks down to the 0.00x ppB level (10^{-10}%). Activation analysis has the advantage that chemical separations can be carried out at a macro scale, since it is possible to add nonactive carrier after irradiation. This also allows a chemical yield to be determined. In some cases it is possible to take advantage of the nuclear properties of the radionuclide by selective countings using Ge(Li) gamma spectrometry and double or triple γ coincidence countings: this may allow a purely instrumental determination, i.e., without chemical separations. Half-lives of the radioisotopes produced by (n,γ) reactions on Ru, Os, Pd, Ir, and Au are suitable for sending the activated samples from the reactor to the analytical laboratory. Thermal neutron activation analysis is less sensitive for Pt and Ag (via ^{110m}Ag) and preconcentrations may be required if the ppB level must be reached. For Rh and Ag (^{110}Ag and ^{108}Ag) the sensitivity is very good, but the short half-life of the radioisotopes formed is a problem: it requires work near the reactor, and, if instrumental analysis fails, fast radiochemical separations are needed. Neutron activation analysis may be most useful to the industry in two respects: function as a reference, and determine very low concentrations, which are beyond the sensitivity of more classical methods. (auth)

27743 (LA–4883) NUCLEAR ANALYSIS RESEARCH AND DEVELOPMENT. Program Status Report, September–December 1971. (Los Alamos Scientific Lab., N. Mex.). Mar 1972. Contract W-7405-eng-36. 16p. Dep. NTIS.

Research progress is reported on: neutron interrogation and nondestructive assay of fissionable materials, materials analysis using isotopic sources, γ and x-ray analysis applications, and detector and instrumentation development. (M.C.G.)

27744 ACTIVATION ANALYSIS OF TRACE IMPURITIES IN SINGLE CRYSTAL SILICON AND IN THIN LAYERS OF SiO_2 AND Si_3N_4 ON SILICON. Kotas, P. (Tesla-Vyzkumny Ustav pro Sdelovaci Techniku, Prague); Kukula, F. Radioisotopy; 13: No. 2, 253–64(1972). (In Czech).

Neutron activation was used for the determination of trace impurities in silicon single crystals and in thin layers of SiO_2 and Si_3N_4 deposited on silicon. The nondestructive determination of impurities in silicon was performed after irradiation, the layers of SiO_2 and Si_3N_4 were etched away with hydrofluoric acid, and silicon was removed in the form of volatile silicon tetrafluoride. The measurement was performed on a gamma spectrometer with a Ge(Li) detector. In a series of analyses W was determined in concentrations of 0.8 to 6 ppM, Cu 0.1 to 7.5 ppM, Na 0.4 to 2 ppM, La 0.2 to 0.4 ppM, Fe 7.5 to 14 ppM, Cr. 2.7 to 3.3 ppM, K 1.8 to 2.4 ppM, and Au 0.002 ppM in single crystal silicon in relation to the surface treatment of the sample. Na was determined in concentrations of 0.4 to 0.7 ppM, Cu 0.4 to 0.7 ppM and As 2 to 3 ppM in thin layers of SiO_2 and Si_3N_4. The relative error of determination was 10 to 15%. The weight of the analyzed layers of SiO_2 and Si_3N_4 was ca 5×10^{-6} g. (auth)

27745 POSSIBILITIES OF THE ACTIVATION ANALYSIS SERVICE IN THE INSTITUTE OF NUCLEAR RESEARCH, REZ. Simkova, M. (Ustav Jaderneho Vyzkumu, Rez, Czech.). Radioisotopy; 13: No. 2, 459–74(1972). (In Czech).

A survey of the work of the activation analysis group of the Institute of Nuclear Research of the Czechoslovak Academy of Sciences and detailed information on the customers' service in this branch of analytical chemistry are given. (auth)

27746 NUCLEAR ANALYSIS. Engelmann, Charles (CEN de Saclay, Gif-sur-Yvette, France). Recherche (Paris); 3: No. 19, 28–34(Jan 1972). (In French).

Nuclear microanalytical methods are reviewed. The different stages involved in activation analysis are recalled. The sensitivity varies according to the nature of the incident particles, being of the order of μg for neutrons, some hundredths of a μg for γ photons, and between 10^{-3} and 10^{-4} μg for protons, helion-3, and

α particles. The possibility of analysis by direct observation of nuclear reactions is discussed. (France)

27747 TOLUENE EXTRACTION OF SOME ELEMENTS AS IODIDES FROM SULPHURIC ACID–POTASSIUM IODIDE MEDIA. APPLICATION TO NEUTRON ACTIVATION ANALYSIS. PART I. EXTRACTION BEHAVIOUR OF As, Au, Bi, Br, Cd, Cu, Ga, Ge, In, Hg, Mo, Pb, Sb, Se, Sn, W, AND Zn. Byrne, A. R. (Jozef Stefan Inst., Ljubljana, Yugoslavia).; Gorenc, D. Anal. Chim. Acta; 59: No. 1, 81-9(Mar 1972).

The solvent extraction with toluene of 17 elements as iodides from sulfuric acid–potassium iodide media was investigated with a view to developing separation methods, particularly for neutron activation analysis. Extraction curves at four or more potassium iodide molarities are presented as a function of acidity for the extractable elements As, Ge, Hg, Sb, and Sn. Information is given for the elements Au, Bi, Br, Cd, Cu, Ga, In, Mo, Pb, Se, W, and Zn over a range of conditions. The extraction curves are characteristic and enable a number of clean and useful separations to be made. (auth)

27748 TOLUENE EXTRACTION OF SOME ELEMENTS AS IODIDES FROM SULPHURIC ACID–POTASSIUM IODIDE MEDIA. APPLICATION TO NEUTRON ACTIVATION ANALYSIS. PART II. DETERMINATION OF ARSENIC AND ANTIMONY IN BIOLOGICAL MATERIALS AT SUBMICROGRAM LEVELS. Byrne, A. R. (Univ. of Ljubljana, Yugoslavia). Anal. Chim. Acta; 59: No. 1, 91-9 (Mar 1972).

A method is described for the neutron activation determination of arsenic and antimony simultaneously in biological materials at the submicrogram level, based on the differences in the extraction behavior of the iodides from sulfuric acid–potassium iodide medium with toluene. Both elements are first extracted from the sulfuric acid solution of the wet-ashed residues and then successively and selectively washed out of the organic phase in quantitative yield. Checks on losses during wet ashing, the validity of the extraction steps, and the complete procedure for both elements are reported. Results are presented for Bowen's standard kale and the N.B.S. standard, orchard leaves SRM 1571. Errors and interferences are discussed. (auth)

27749 NEUTRON ACTIVATION METHOD FOR THE DETERMINATION OF COBALT IN BLOOD. Pelekis, Z. E.; Pelekis, L. L.; Taure, I. Ya.; Kizane, G.; Rusteika, P. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 6, 9-13(1971). (In Russian).

Two modifications (instrumental and radiochemical) for the determination of cobalt in blood by neutron activation analysis were developed. The irradiation time was 80 h in a neutron flux of 3×10^{13} n/cm^2·sec. The measurements were carried out with a Ge(Li) detector. The volume of the detector was 45 cm^3 and the measuring time was 3 h. Under these conditions the detection limit was 4×10^{-9} g Co in 100 to 300 mg dry blood. (auth)

27750 NON-DESTRUCTIVE ACTIVATION ANALYSIS OF FLUID INCLUSIONS IN FLUORITE. Wickman, Frans E.; Khattab, Khattab M. (Pennsylvania State Univ., University Park). Econ. Geol.; 67: No. 2, 236-9(Mar-Apr 1972).

The Na/Cl, Na/Br, and Cl/Br ratios in some fluorites (sample weight 20 to 30 mg) were studied by nondestructive activation analysis. Some experiments are described, which show that the analyses refer to the liquid inclusions. One specimen studied in detail showed a Na/Cl ratio corresponding to a NaCl solution. Its Cl/Br weight ratio of 63 contrasts to the ratios of seawater as well as most surface and subsurface waters, but is similar to some brines. Some possible explanations are mentioned. The method seems useful in the study of liquid inclusions, especially since it can be used for several other elements and other minerals. (auth)

27751 USE OF ELASTIC PARTICLE SCATTERING FOR PRELIMINARY SURVEY EXAMINATIONS IN POSITIVE-ION MICROPROBE ANALYSIS. Pierce, T. B.; Peck, P. F.; Cuff, D. R. A. (Atomic Energy Research Establishment, Harwell, Eng.). Analyst; 97: No. 1152, 171-3(Mar 1972).

The intensity of particles scattered elastically from a sample during bombardment with positive ions provides a useful complement to existing positive-ion microprobe techniques. This approach can be used to give a rapid preliminary indication of gross elemental distributions, which is particularly valuable for identifying areas that require more detailed examination. (auth)

27752 SUB-PICOGRAM ASSAY OF BIOGENIC MATERIALS: THEORETICAL APPLICATION OF INTERACTIONS WITH ISOTOPES THAT YIELD HEAVY IONIZING PARTICLES UPON NEUTRON EXPOSURE AND USE OF RADIOGRAPHIC DIELECTRIC TRACK REGISTRATION TECHNIQUES. Nelson, S. C.; Barchas, J. D. (Stanford Univ., Calif.). J. Theor. Biol.; 34: No. 1, 73-85(Jan 1972).

A method of devising an assay for the sub-picogram measurement of biogenic agents is described. The analytical procedures involve the formation of stable complexes or derivatives from the interaction of biogenic agents and isotopes that yield heavy ionizing particles on neutron bombardment, separation of the derivatives or complexes from interfering substances by electrophoresis and/or paper or thin layer chromatography, and quantitation of the agent by measuring the neutron-induced particle tracks (from the isotope) in dielectric films. The basic techniques of the assay would be applicable to a variety of biological agents or chemical substances that form complexes or derivatives with isotopes that emit heavy ionizing particles on neutron exposure. Theoretically, the method of assay for biological agents would be sensitive in the femtogram (10^{-15} g) range. (auth)

27753 STUDIES OF INORGANIC SAMPLES OF POLLUTION AEROSOLS BY NONDESTRUCTIVE ACTIVATION ANALYSIS. Dams, R. (State Univ., Ghent). J. Belge Radiol.; 54: 735-45 (Nov-Dec 1971). (In Dutch).

A nondestructive procedure was developed, using neutron activation and high resolution gamma spectrometry for quantitative analysis of 33 elements in natural and pollution aerosols. This technique was applied to a study of the diurnal concentration variations of the elements as a function of the meteorological conditions. In a second study the area-wide distribution of the elements was investigated in an important industrial area. (auth)

27754 NUCLEAR ANALYSIS METHODS FOR PROBLEMS IN ENVIRONMENTAL SCIENCE: THE DETECTION AND QUANTITATION OF TRACE ELEMENTS AND SUBSTANCES. Leddicotte, G. W. (Georgia Inst. of Tech., Atlanta). Develop. Appl. Spectrosc.; 9: 417-35(1971).

From Developments in applied spectroscopy symposium; Chicago, Ill. (2 Jun 1970).

Nuclear methods of analysis, which can be used for research in environmental science, are reviewed. They are usually categorized as being either radioactive tracer, induced radioactivity, or nuclear reaction methods. Included in radioactive tracer methods are isotopic and nonisotopic as well as natural radioactivity measurements and radiometric titrations. Induced activity methods include neutron activation and charged particle activation analysis. Nuclear radiation reaction methods include absorption, transmission, and scattering measurements. (J.G.B.)

27755 COMPARISON OF OPTICAL FLUORESCENCE, ELECTRON MICROPROBE, AND NEUTRON ACTIVATION METHODS FOR CHROMIUM ANALYSIS IN RUBY. Lipson, Herbert G.; Buckmelter, James R.; Fitzgerald, John J. (Air Force Cambridge Research Labs., Bedford, Mass.). Develop. Appl. Spectrosc.; 9: 437-48(1971).

From Developments in applied spectroscopy symposium; Chicago, Ill. (2 Jun 1970).

The results of optical, electron microprobe, and neutron activation analysis methods for chromium determination in ruby are compared. Relative chromium concentrations down to the ppM range were determined optically in small sample volumes from intensities of R-line fluorescence excited with the 4880 Å line of a cw argon gas laser. In conjunction with standards, concentrations close to the sample surface were obtained from electron microprobe measurements while bulk concentrations were determined from neutron activation analysis. In addition, local inhomogeneities were revealed by both optical and electron microprobe techniques. Advantages and limitations for each method with respect to standards, sensitivity, sampling, and interference of other impurities are discussed. (auth)

27756 APPLICATION OF RADIOACTIVATION TO THE SEQUENTIAL SEPARATION OF ANTIMONY, CADMIUM, CHROMIUM, COBALT, IRON, TIN, AND ZINC FROM ALUMINUM AND LEAD BY ION-EXCHANGE CHROMATOGRAPHY. Bishay, Tharwat Z. (Scottish Research Reactor Centre, Glasgow). Anal. Chem.; 44: No. 6, 1087-90(May 1972).

A separation scheme applicable to the determination of antimony, cadmium, chromium, cobalt, iron, tin, and zinc in aluminum and lead is described. Samples were irradiated in a thermal neutron flux of 10^{13} n/cm^2/sec for 36 hours and left to decay for two weeks before processing. Activity measurements were made using a NaI(Tl) detector connected to a 100-channel analyzer. Mean percent standard deviation varied from 2.67 for iron in aluminum to 13.60 for cobalt in lead. (J.G.B.)

27757 DETERMINATION OF OXYGEN IN ALUMINUM BY ^{3}He ACTIVATION. Vialatte, Bernard (CEN de Saclay, Gif-sur-Yvette, France); Revel, Gilles. Anal. Chem.; 44: No. 6, 1077-9(May 1972).

Oxygen was determined in Al by helium-3 activation involving the reactions, $^{16}O(^{3}He,p)^{18}F$ and $^{16}O(^{3}He,n)^{18}Ne$. The half-life of the radioisotope produced (110 min) allows time for etching of the surface and even, if necessary, for the chemical separation of ^{18}F. Interferences may be avoided by use of an irradiation energy of between 8 and 12 MeV. Oxygen content in double electrolysis Al (99.999%) was found to be some tenths of a microgram/gram of Al. A limit of 0.05 μg of O/gram of Al was found in zone-refined Al. (J.G.B.)

27758 DETECTION OF CHLORINE ON ALUMINUM BY MEANS OF NUCLEAR REACTIONS. Knudson, A. R.; Dunning, K. L. (Naval Research Lab., Washington, D. C.). Anal. Chem.; 44: No. 6, 1053-5(May 1972).

A number of methods of analysis, all involving nuclear reactions induced by the bombardment of specimens with positive ions from a 5-MV Van de Graaff, were investigated for the determination of small quantities of chlorine on aluminum surfaces. Experimental parameters and results for the four most promising methods are summarized. Method I is based on the observation of γ rays emitted in the decay of ^{38}Cl formed in the $^{37}Cl(d,p)^{38}Cl$ reaction. Method II, which is based on detecting the high-energy electrons emitted by the ^{38}Cl, was judged the least practical of the four methods. Method III based on $\gamma-\gamma$ coincidence measurements allows the detection of Cl down to about 0.2 $\mu g/cm^2$, requires a more complex electron configuration than the other methods, and is therefore more time-consuming. The use of ^{4}He elastic scattering is the simplest, quickest, and most sensitive of the methods described. Measurements indicate a detectability limit of 0.015 $\mu g/cm^2$ of chlorine for a 160-μC bombardment of the sample. (J.G.B.)

27759 NEUTRON ACTIVATION DETERMINATION OF ARSENIC AND ANTIMONY IN OCEAN WATER AFTER THEIR CONCENTRATION WITH FERRIC HYDROXIDE. Ryabinin, A. I.; Romanov, A. S.; Khatamov, Sh.; Kist, A. A.; Khamidova, R. (Sea Hydrophysical Inst., Sevastopol, USSR. Inst. of Nuclear Physics, Ulugbek, USSR). Zh. Anal. Khim.; 27: No. 1, 94-9(Jan 1972). (In Russian).

A neutron activation method is suggested for simultaneous determination of arsenic and antimony in oceanic water from a single sample without radiochemical separations. The method includes preliminary concentration of the determined elements by their coprecipitation with ferric hydroxide. The error of the determination of both elements is not greater than 15%. (auth)

27760 EXPRESS DETERMINATION OF GERMANIUM IN ORGANIC COMPOUNDS BY THE METHOD OF ACTIVATION WITH FAST NEUTRONS. Duda, I.; Obtemperanskaya, S. I.; Dudova, I. V. (Moscow State Univ.). Zh. Anal. Khim.; 27: No. 1, 155-62(Jan 1972). (In Russian).

A nondestructive method is suggested for determining germanium in organic compounds after their activation with fast neutrons of a generator. The determination is carried out by measurement of the activity of the ^{75m}Ge isomer, which is formed by the reaction $^{76}Ge(n,2n)^{75m}Ge$. The sensitivity of the determination is 357 imp/mg of germanium at a flux of 1.3×10^{8} n/cm^2 · sec or 1.15 mg under the condition that the activity in the photopeak $E_\gamma \simeq 40$ keV is three times higher than the square error of the background measuring in the same region of the spectrum and the same recording time. One determination takes 12 to 15 min. (auth)

27761 APPLICATION OF NEUTRON TECHNIQUES IN THE NONDESTRUCTIVE ASSAY OF FISSILE MATERIALS. Stegemann, D. (Univ., Hanover). Nucl. Technol.; 14: No. 1, 59-64 (Apr 1972).

Monoenergetic neutron bursts in heavy moderators are being examined for application to the nondestructive assay of fissile material in fuel samples. The goal of these assays is the determination of fissile isotope content, generally in the presence of other fissile or fertile isotopes. The technique utilizes the relationship between neutron energy and the slowing-down time, or time elapsed after the burst in the heavy moderator. The slowing-down-time spectrometer, a lead cube into which 14-MeV neutrons are pulsed, is used to determine the fissile isotope content. Differences in fission cross sections at specific energies are used to discriminate between fissile isotopes in the same sample. (auth)

27762 COPPER ASSAY OF BIOMATERIALS WITH NEUTRON ACTIVATION. Spronk, N.; Van Hoek, R. J. (Free Univ., Amsterdam). Nucl. Technol.; 14: No. 1, 96-104(Apr 1972).

The ^{64}Cu production in biological tissues after reactor neutron activation for copper determination was compared in different types of tissue and in different sizes of samples. The comparison showed that the composition of the animal tissue should be taken into account since it is a source of interference during the neutron activation determination of copper. Undirectional deviations of 10% depending on sample type and size can be caused by this interference. The Cu contents in pooled tissues of Lymnaea stagnalis are examples. If properly corrected, these were 21 μ/g for dry intestinal tissue and 5.7 μ/g for shell. (auth)

Chemical and Spectral Procedures

Refer also to abstracts 27966, 27977, 28077, 28285, and 30212.

27763 (BARC-560) ANHYDROUS $Pu(SO_4)_2$ AS A PRIMARY STANDARD FOR PLUTONIUM AND ITS USE FOR STANDARDISING THE POTENTIOMETRIC METHOD OF ESTIMATION OF PLUTONIUM. Nair, G. M.; Singh, N. P.; Chander, Keshav; Joshi, J. K.; Godbole, A. G.; Shah, P. M.; Ramaniah, M. V. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 13p. Dep. NTIS (U. S. Sales Only).

Pure anhydrous $Pu(SO_4)_2$ was prepared and analyzed for constituents and for impurities. From the favorable properties of the compound it was considered a suitable material for a primary standard for plutonium. The analysis results on standard $Pu(SO_4)_2$ solutions prepared from anhydrous $Pu(SO_4)_2$ showed that the accuracy of the potentiometric method used for the assay of plutonium in PuO_2 was within the precision, when the quantity of plutonium analyzed was in the range of 1 to 20 mg per aliquot. Impurities such as uranium (up to 3 mole % of Pu) and iron (up to 0.8 mole % of Pu) were found not to interfere in this method of estimation. However, the presence of large quantities of uranyl salts at U/Pu ratios higher than 250 was found to affect the results. This interference due to the uranyl salts was found to be independent of the anion in the salt as was tested by using both $UO_2(NO_3)_2$ and UO_2SO_4. (auth)

27764 (IEA-246) SEMIQUANTITATIVE SPECTROGRAPHIC ANALYSIS OF COMMON IMPURITIES IN URANIUM COMPOUNDS. Deppe, Alzira Lourenco; Lordello, Antonio Roberto (Instituto de Energia Atomica, Sao Paulo (Brazil)). Sep 1971. 21p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

A semiquantitative routine spectrometric method is described for direct determination of B, Cd, P, Fe, Mn, Mg, Pb, Cr, Sn, Ni, Bi, Mo, V, Cu, Ag, Zn, Si, and Al, in the parts per million range in uranium compounds. The method, based on a carrier distillation technique, utilizes gallium oxide and sodium fluoride as carriers. The method fulfills the requirements of precision and sensitivity for specification analysis of reactor-grade uranium. (auth)

27765 (N-72-14147) SIMPLE SPECTROPHOTOMETRIC METHOD FOR DETERMINATION OF ZIRCONIUM OR HAFNIUM IN SELECTED MOLYBDENUM-BASE ALLOYS. Dupraw, William A. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jan 1972. 16p. (NASA-TM-X-2452; E-6527). NTIS.

A simple analytical procedure is described for accurately and precisely determining the zirconium or hafnium content of molybdenum-base alloys. The procedure is based on the reaction of the reagent Arsenazo III with zirconium or hafnium in strong hydrochloric acid solution. The colored complexes of zirconium or hafnium are formed in the presence of molybdenum. Titanium and rhenium in the alloy have no adverse effect on the zirconium or hafnium complex at the following levels in the selected aliquot: Mo, 10 mg; Re, 10 mg; Ti, 1 mg. The spectrophotometric measurement of the zirconium or hafnium complex is accomplished without prior separation with a relative standard deviation of 1.3 to 2.7%. (auth) (STAR)

27766 DETERMINATION OF SODIUM, MAGNESIUM, AND CALCIUM IN YTTRIUM OXIDE BY FLAME EMISSION AND ATOMIC ABSORPTION SPECTROMETRY. Ishizuka, Toshio; Sunahara, Hiroshi (Government Industrial Research Inst., Nagoya, Japan). Jap. Anal.; 21: No. 2, 264-70(Feb 1972). (In Japanese).

Sodium, magnesium, and calcium were determined in high-purity yttrium oxide by flame emission and atomic absorption spectrometry using an air-hydrogen flame. The effects of several inorganic acids used in the procedure, some metals, and high concentration of yttrium on the determination of sodium, magnesium, and calcium were investigated. The emission and absorption of sodium are almost unaffected by inorganic acids except that they are gradually decreased with increasing concentration of phosphoric acid. The absorption of magnesium is almost unaffected by less than 0.1M of hydrochloric acid and nitric acid,

but considerably decreased by 1M concentrations. It is considerably decreased by sulfuric acid and phosphoric acid. Inversely, it is increased about 50% by perchloric acid. The emission and absorption of calcium are similar to those of magnesium, but they are more decreased by nitric acid, sulfuric acid, and phosphoric acid. The emission and absorption of sodium are almost unaffected by yttrium, magnesium, and calcium. The absorption of magnesium is almost unaffected by sodium, but increased about 50% by yttrium and calcium. The emission and absorption of calcium are not particularly affected by sodium and less than 100 ppM of magnesium, but they are appreciably decreased at the concentration of 500 ppM of magnesium. The emission is increased in the range of 1 to 1000 ppM of yttrium, and rapidly decreased at the concentration of 5000 ppM of yttrium. The absorption is increased at the concentration of 1 ppM of yttrium, and rapidly decreased with increasing concentration of yttrium. It was found that hydrochloric acid or perchloric acid is suitable for dissolving the yttrium oxide sample, and sodium, magnesium, and calcium were directly determined in the large amount of yttrium by a standard addition method. A sample of 99.9% yttrium oxide was dissolved in hydrochloric acid and analyzed by flame emission and atomic absorption methods. Concentrations of 40 to 850 ppM of sodium were determined with coefficients of variation (cv) of ± 0.8 to ± 6.8% by flame emission method and ± 0.7 to ± 2.9% by atomic absorption method, 1.5 to 4.5 ppM of magnesium with cv of ± 1.1 to ± 5.0% by atomic absorption method, and 42 to 4200 ppM of calcium with cv of ± 2.4 to ± 6.9% by flame emission method and ± 0 to ± 10.7% by atomic absorption method. (auth)

27767 DETERMINATION OF MOLYBDENUM IN STEEL BY ATOMIC ABSORPTION SPECTROMETRY. **Wada, Kenji (Sasebo Technical Coll., Nagasaki). Jap. Anal.; 21: No. 2, 221-5(Feb 1972). (In Japanese).**

Interference suppression to coexisting elements by sodium sulfate for the determination of molybdenum in steel by atomic absorption spectrometry in an air-acetylene flame was examined. An addition of 1% sodium sulfate was effective in preventing the interference of a large number of coexisting elements in Mo at 20 μg/ml, for example, Fe at 10 mg/ml, Al, Mn, W at 0.5 mg/ml, Cr at 0.3 mg/ml. The instrument used was an Hitachi 207 atomic absorption spectrophotometer. The steel samples analyzed were C steel (Mo, 0.014%, Cr, 0.05%), Ni–Cr steel (Mo, 0.015%, Cr, 0.7%), Cr–Mo steel (Mo, 0.19%, Cr, 1.1%), stainless steel (Mo, 0.073%, Cr, 18.6%) and high-speed steel (Mo, 0.51%, Cr, 3.9%). A 1-gram portion of steel was dissolved in a mixture of 10 ml of concentrated hydrochloric acid and 5 ml of concentrated nitric acid, and warmed gently to commence reaction. When the reaction ceased, the solution was boiled to drive off nitrogen dioxide for 2 to 3 minutes. The solution was diluted with cold water and filtered, and the sample solution made up containing 1 gram sodium sulfate to give a final volume of 100 ml. The high-speed steel was dissolved in a mixture of 10 ml of concentrated hydrochloric acid, 5 ml of concentrated nitric acid, and 10 ml of concentrated phosphoric acid. Mo was determined successfully in steel, but not in stainless steel. This implies that sodium sulfate does not completely eliminate the interference for the high concentration of chromium in stainless steel. The sensitivity was 0.6 ppM Mo/1% absorption. (auth)

27768 STUDIES ON ANALYTICAL METHODS BY AMPEROMETRIC TITRATIONS USING A ROTATING PLATINUM ELECTRODE. XXI. NEW AUTOMATIC APPARATUS FOR AMPEROMETRIC TITRATION AND ITS PRECISION IN ARGENTOMETRY; COMPARISON WITH AUTOMATIC POTENTIOMETRIC TITRATION. **Ikeda, Sanae (Tokushima Univ., Japan). Jap. Anal.; 21: No. 2, 177-83(Feb 1972). (In Japanese).**

A new type of automatic amperometric titrator was constructed altering the input circuit of the automatic recording apparatus for potentiometric titration developed by S. Miyake (Hiranuma Type RAT-1). Conditions for its use and the precision of analytical results were investigated by means of short-circuit amperometric argentometry of halides using a rotating platinum wire electrode (1000 rpm) and an SCE. The titration curves obtained by the proposed apparatus were well defined, and it was found to be possible to titrate halides more rapidly, precisely, and sensitively than with the potentiometric titration. Chloride solutions could be titrated rapidly using the proposed apparatus at the concentration range 10^{-2} to 10^{-4} N. Bromide, iodide, and thiocyanate solutions were titrated by the proposed stepwise addition method of titrant at the concentration range of 10^{-2} to 10^{-5} N. (auth)

27769 COMPLEXOMETRIC DETERMINATION OF RARE EARTH ELEMENTS BY MEANS OF CARBOXYARSENAZO. **Shukurov, S. Sh.; Shemyakin, F. M.; Basargin, N. N.; Salakhutdinov, U. I. (State Medical Inst., Dushanbe, USSR). Dokl. Akad. Nauk. Tadzh. SSR; 14: No. 11, 58-60(1971). (In Russian).**

The use of carboxyarsenazo (more commonly Arsenazo III) in titrimetric analyses of rare earths is based on inner complex formation optimally at a pH of 3.5 to 5.0. The complex is readily characterized by its maximum light absorption at 660 nm, and assures a high degree of sensitivity; the minimum rare earth concentration for visual estimation of the end point in a titration is 0.1 μg/ml. Data on individual rare earth determinations (La, Sm, Pr) in the presence of other ions (citrate, copper) are given. (K.S.W.)

27770 DIRECT DETERMINATION OF CALCIUM IN ZIRCONIUM AND ZIRCALOY-2 BY FLAME-EMISSION SPECTROPHOTOMETRY WITH THE NITROUS OXIDE-ACETYLENE FLAME. **Ghersini, G. (CISE, Milan); Omenetto, N.; Benetti, P. Analyst; 97: No. 1152, 182-8(Mar 1972).**

A method is proposed for direct determination of calcium impurities in nuclear-grade zirconium and Zircaloy-2 by flame-emission spectrophotometry with the nitrous oxide–acetylene flame. Because chemical manipulations are limited to the dissolution of the sample, the method is very simple and rapid, and it gives a precision that compares favorably with that of other available methods. By the method described, 6 to 20 ppM of calcium in zirconium and Zircaloy-2 were determined with standard deviations ranging from 0.8 to 1.8 ppM. The spectral interference from zirconium, the choice of instrumental conditions and the procedures for zirconium background correction are discussed. (auth)

27771 FIELD OBSERVATIONS ON THE KAKORTOKITES OF THE ILIMAUSSAQ INTRUSION, SOUTH GREENLAND, INCLUDING MAPPING AND ANALYSES BY PORTABLE X-RAY FLUORESCENCE EQUIPMENT FOR ZIRCONIUM AND NIOBIUM. **Bohse, H. (Univ. of Copenhagen); Brooks, C. K.; Kunzendorf, H. Groenlands Geol. Unders. Rap.; No. 38, 43p(1971).**

Detailed mapping, sample collection, and studies of zirconium and niobium distributions in the kakortokites of the Ilimaussaq intrusion were carried out. Each of the 29 major rhythmic units mapped and a comprehensive sample collection made for further work. The depth of unconsolidated material was of the order of 20 m with a maximum angle of rest of some 20°. Faults, fine-scale layering, trough banding, the border pegmatite, and later intrusions are described. A program of field and laboratory determinations of Zr and Nb delimited their distribution within these rocks and allowed a first estimate of the total, easily-accessible quantities of these elements to be made. (auth)

27772 DETERMINATION OF RUBIDIUM AND CESIUM IN GEOLOGICAL MATERIALS BY ATOMIC EMISSION SPECTROPHOTOMETRY WITH A NITROUS OXIDE–ACETYLENE FLAME. **Allen, W. J. F. (Roan Consolidated Mines Ltd., Kalulshi, Zambia). Anal. Chim. Acta; 59: No. 1, 111-17(Mar 1972).**

An atomic emission spectrophotometric procedure is presented for the determination of rubidium and cesium at the per cent and ppM levels. A nitrous oxide–acetylene flame and a potassium ionization buffer are used. There is no need for prior separation, pre-concentration, or general matrix matching of standards. (auth)

27773 ANALYSIS OF TUNGSTEN CARBIDES BY OPTICAL EMISSION SPECTROMETRY. **Knott, A. C.; Kinson, K.; Belcher, C. B. (Broken Hill Proprietary Co. Ltd., Shortland, Australia). Anal. Chim. Acta; 59: No. 1, 119-25(Mar 1972).**

Three direct-reading, optical emission spectrometric techniques that use spark excitation are described for the analysis of tungsten carbide alloys in powder and compacted forms. The techniques cover oxidized samples fused with lithium tetraborate–lanthanum tetraborate and briquetted with graphite, powdered carbide samples, which are briquetted with lithium tetraborate–lanthanum tetraborate and graphite, and cemented carbide metal samples. The preparation of reference standard samples and spectral interferences are described. The relative standard deviations are 0.005 to 0.031 for major and 0.02 to 0.26 for minor elements, and the best precision is obtained with oxide briquettes. (auth)

27774 GAS CHROMATOGRAPHY OF RARE EARTH CHELATES OF ISOBUTYRYLPIVALYLMETHANE. **Utsunomiya, Kei (Kyoto Univ.). Anal. Chim. Acta; 59: No. 1, 147-51(Mar 1972).**

Chelates of scandium, yttrium, and the rare earths were prepared, and their thermogravimetric and gas chromatographic behaviors were investigated. The possibility of direct determinations by measuring the peak height was also surveyed, although complete separation and simultaneous determination have still not been achieved. (M.C.G.)

27775 EVALUATION OF TETRAPHENYLOBORATE PRECIPITATES. I. INDIRECT PHOTOMETRIC DETERMINATION OF

POTASSIUM, RUBIDIUM, AND CESIUM WITH 1.1'-DIANTHRIMIDE. Raber, H.; Likussar, W. (Univ., Graz). Mikrochim. Acta; No. 1, 92-6(1972). (In German).

The alkali tetraphenylborates are decomposed by strong acids into boric acid and a mixture of organic products. The resulting boric acid can be determined photometrically in known manner with 1,1'-dianthrimide. A working procedure for the indirect spectrophotometric determination of potassium, rubidium, and cesium is given. The method was tested statistically and with reference to check analyses. (auth)

27776 SIMULTANEOUS MICRODETERMINATION OF IODINE AND CHLORINE OR IODINE AND BROMINE IN ORGANIC COMPOUNDS. Hassan, S. S. M.; Elsayes, M. B. (Ain Shams Univ., Cairo). Mikrochim. Acta; No. 1, 115-21(1972).

A micromethod for simultaneous determination of iodine and chlorine or iodine and bromine in organic compounds is described. After combustion in an oxygen-filled separatory funnel containing acidic sodium nitrite, iodine is produced, separated by carbon tetrachloride, and oxidized with bromine water to iodate. After removal of carbon tetrachloride and excess bromine, the iodate is determined iodometrically. The aqueous combustion product is determined mercurimetrically for either chlorine or bromine. The average recoveries are 98.7%, 100.7%, and 100.6% with iodine, chlorine, and bromine in mixtures of their organically bound compounds. Microdetermination of iodine in the presence of other halogens using sodium nitrite as absorbing agent and Leipert's method is described. (auth)

27777 WET-CHEMICAL DETERMINATION OF BORON AND NIOBIUM IN STEEL. Gagliardi, E.; Hoellinger, W. (Univ., Graz). Mikrochim. Acta; No. 1, 136-44(1972). (In German).

The spectrophotochemical determination of boron and niobium in steel is described. Boron is converted, by means of hydrofluoric acid and Nile blue A, into a complex and measured. The alloying elements ordinarily found in steel do not interfere, with the exception of tantalum. Niobium following, the extraction of iron with methyl ethyl ketone, is determined using 1-(2-pyridylazo) resorcinol (PAR). Interfering foreign ions are masked by means of EDTA and pyridine. The dependence of the extinction on the masking agents was investigated. (auth)

27778 MICROQUANTITATIVE DETERMINATION OF IODINE IN FOOD PRODUCTS BY ARGENTOPOTENTIOMETRIC TITRATION. Mokhnach, V. O.; Popova, E. R. (Botanical Inst., Moscow. Donets Inst. of Soviet Trade, USSR). J. Appl. Chem. USSR (Engl. Transl.); 44: No. 9, 2011-13(Sep 1971).

Translated from Zh. Prikl. Khim.; 44: No. 9, 1979-81(Sep 1971).

The proposed method of argentopotentiometric titration can be used for determination of small amounts of iodine in all its forms. The method is suitable under conditions making the use of colored indicators impossible (in colored or turbid solutions). The turbidity or color of the test solutions does not affect the results. The method is simple and does not require scarce reagents, and is not time-consuming. The instrument time does not exceed 3 min, and the whole determination takes 12 to 15 min. The sensitivity, accuracy, simplicity, and speed of this method make it suitable for production control. (auth)

27779 RAPID METHOD OF CONFIRMATION OF FISSIONABLE MATERIALS WITH THE ETCH-PIT COUNTING METHOD. Nishiwaki, Y. (Kinki Univ., Osaka); Kawai, H.; Morishima, H.; Iwata, S.; Tsuruta, T. pp 267-75 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

Fission fragments leave scars on insulators made of glass, mica, and plastic. The scars on the surface of insulator material caused by the fission fragment can be etched by suitable chemical treatment to form etch-pits on the surface or etch-holes in the foil. The number of etch-pits may be counted by the ordinary optical microscope and those of etch-holes by the spark counter. This method can be used as a rapid method of estimating the amount of fissionable material. Since the fissionable materials tested in this study are alpha emitters, the amount of the alpha-emitting fissionable material may be estimated by measuring alpha rays. However, even if the fraction containing a certain fissionable material is separated by ordinary chemical analysis, a number of other interfering nonfissionable alpha, beta, and gamma emitters may be included in the fraction. In such cases, the etch-pit or etch-hole counting method may give a more direct and less confusing estimate of fissionable material without interference from contamination by other nonfissionable alpha, beta, or gamma emitters. Considering the background, the minimum detectable number of etch-pits or etch-holes may be about $10^2/cm^2$. However, the reasonable detectable number of etch-pits or etch-holes per unit area may be estimated at about $10^3/cm^2$. Based on these figures, the necessary neutron fluence and the necessary volume of water samples containing maximum permissible concentration of natural Th, natural U, or ^{239}Pu are estimated. (auth)

27780 EXTRACTION OF URANIUM AND ITS PHOTOMETRIC DETERMINATION WITH OXINE AND DIBENZOYLMETHANE. Adam, J.; Pribil, R. (Charles Univ., Prague. Inst. of Polarography, Prague). Collect. Czech. Chem. Commun.; 37: No. 1, 129-36(Jan 1972).

A highly selective extraction of uranium from sulfuric acid (pH 1.5 to 4) and sodium sulfate, with a chloroform solution of trioctylamine (Alamine S-336), was developed. Uranium is determined directly in the extract with oxine by measuring the absorbance at 480 nm or 380 nm, according to the expected concentration. Beer's law holds for concentrations up to 250 μg, or 83 μg, in 1 ml of extract. For microgram amounts, the reaction with dibenzoylmethane was used. Beer's law holds up to a concentration of 20 μg in 1 ml of extract. The latter method allows determination of traces of uranium in very unfavorable concentrations of accompanying elements (at least to the ratio 1:10,000). (auth)

27781 GAS PHASE CHROMATOGRAPHY OF SOME THENOYLTRIFLUOROACETONE CHELATES. Jacquelot, P.; Thomas, G. Univ., Lyon). J. Chromatogr.; 66: No. 1, 121-8(22 Mar 1972). (In French).

Gas–liquid chromatographic separations and quantitative analysis of thenoyltrifluoroacetonates of beryllium(II), aluminum(III), scandium(III), vanadium(IV), chromium(III), cobalt(II), nickel(II), and copper(II) were carried out, on lightly loaded columns, at temperatures below 270°C. For nickel and cobalt, the use of thenoyltrifluoroacetonate adducts with diethylamine is of interest. (auth)

27782 DEVELOPMENTS IN APPLIED SPECTROSCOPY. VOLUME 9. Twenty-First Annual Mid-America Spectroscopy Symposium, Held in Chicago, Illinois, June 2–5, 1970. Grove, E. L.; Perkins, A. J. (eds.). New York; Plenum Publishing Corporation (1971). 460p. $19.50. (CONF-700667).

Twenty-three papers are included, five of which are abstracted individually for NSA. The remaining papers deal with low-temperature absorption spectrometry, gas–solid interactions in infrared spectroscopy, mass spectrometry, emission-atomic absorption spectroscopy, and x-ray spectroscopy. (J.G.B.)

For abstracts of individual papers see: 27754, 27755, 27783, 27784, and 27830.

27783 HIGH PRECISION DETERMINATION OF MICROGRAM QUANTITIES OF RARE EARTH METALS BY X-RAY EMISSION SPECTROGRAPHY OF ION EXCHANGE PAPER DISK. Walton, Roger D. (General Electric Co., St. Petersburg, Fla.). Develop. Appl. Spestrosc.; 9: 287-305(1971).

From Developments in applied spectroscopy symposium; Chicago, Ill. (2 Jun 1970).

Rare earth metals, in the range of 0 to 250 micrograms, were extracted quantitatively from perchloric, nitric, or hydrochloric acid solutions by strong acid ion exchange paper disks in the sodium ion form. After the exchange was completed, the ion exchange paper disk was placed in a rotating sample holder and the amount of rare earth metals exchanged was determined by x-ray-emission spectrography. At the 10-microgram level, the accuracy has a mean error of 2% with a precision of 1.5% relative standard deviation. The procedure was applied to Sc^{3+}, Y^{3+}, Ce^{4+}, Pr^{3+}, Nd^{3+}, Sm^{3+}, Eu^{3+}, Gd^{3+}, Tb^{3+}, Dy^{3+}, Ho^{3+}, Er^{3+}, Tm^{3+}, Yb^{3+}, and Lu^{3+}. (auth)

27784 TABLES OF X-RAY MASS ATTENUATION COEFFICIENTS FOR 87 ELEMENTS AT SELECTED WAVELENGTHS. Bracewell, Bobby L.; Veigele, William J. (Kaman Sciences, Colorado Springs, Colo.). Develop. Appl. Spectrosc.; 9: 357-400(1971).

From Developments in applied spectroscopy symposium; Chicago, Ill. (2 Jun 1970).

Tables of x-ray mass attenuation cross sections were prepared for 87 elements with atomic numbers between one and 94 at 99 selected wavelengths of interest to spectroscopists, microprobe users, diffraction workers, etc. The tables were derived from a recent x-ray cross section compilation covering the energy range 0.1 keV to 1 MeV. A brief description is given of the assumptions and methods in preparing the original compilation to point out the limitations of the derived tables. (auth)

27785 SENSITIVITY OF DETECTION OF THE ELEMENTS BY PHOTOELECTRON SPECTROMETRY. Wagner, C. D.

(Shell Development Co., Emeryville, Calif.). Anal. Chem.; 44: No. 6, 1050-3(May 1972).

Relative sensitivity for the detection of elements by x-ray photoelectron spectrometry was studied. Elemental sensitivity was determined experimentally using a Varian spectrometer by examining the spectra of a variety of sodium and fluorine compounds. The intensities of the strong lines are referred to that of the F 1s line as a standard. The Na 1s line is used as a secondary standard. Infinitely thick samples were used; therefore, the data are for samples of uniform composition with depth. Relative atomic sensitivities for 43 elements are tabulated. (J.G.B.)

27786 AUGER LINES IN X-RAY PHOTOELECTRON SPECTROMETRY. Wagner, C. D. (Shell Development Co., Emeryville, Calif.). Anal. Chem.; 44: No. 6, 967-73(May 1972).

A study was made of Auger electrons detectable from all elements, using Al Kα photon irradiation in an x-ray photoelectron spectrometer. Auger electrons from forty-four of the elements are readily observable, many in high intensity. There are three series, the KLL for elements boron through magnesium, the LMM for sulfur through selenium, and the MNN for ruthenium through neodymium. Strong chemical effects are noted on the shapes, intensities, and locations of some of the Auger lines. (auth)

27787 STUDY OF THE CHEMISTRY OF THE REACTIONS BETWEEN THE IONS OF MULTIVALENT ELEMENTS AND ORGANIC REAGENTS. COMMUNICATION 25. THE INTERACTION OF MOLYBDENUM(VI) WITH TRIHYDROXYFLUORONES. Antonovich, V. P.; Shelikhina, E. I.; Zhadanov, B. V.; Nazarenko, V. A. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim.; 27: No. 1, 100-7(Jan 1972). (In Russian).

Complex formation between molybdenum(VI) and 9-propyl- and 9-trichlormethyl-2,3,7-trihydroxy-6-fluorone was examined. Spectrophotometric characteristics and the composition of the compounds formed were studied and their charge found. The chemistry of formation of molybdenum trihydroxyfluoronates was established and confirmed by the electronic and infrared absorption spectra of the compounds studied. Recommendations are given on the choice of the optimum concentration of hydrogen ions during the photometric determination of molybdenum by means of trihydroxyfluorones. (auth)

27788 DIFFERENTIAL SPECTROPHOTOMETRIC METHOD FOR DETERMINING NIOBIUM WITH 4-(2-PYRIDYLAZO)RESORCINOL. Dobkina, B. M.; Kuchmistaya, G. I.; Nadezhdina, G. B. (State Scientific-Research and Design Inst. of the Rare Metal Industry, Moscow). Zh. Anal. Khim.; 27: No. 1, 194-6(Jan 1972). (In Russian).

A differential spectrophotometric method for determining niobium using 4-(2-pyridylazo)resorcinol was developed. The method was applied to the analysis of niobium hydroxide, niobate, and tantalum–niobium alloys. (auth)

27789 USE OF THE IONIC ASSOCIATE OF ZIRCONIUM WITH BENZOIC ACID AND RHODAMINE B IN ANALYSIS. Beltyukova, S. V.; Poluektov, N. S.; Meshkova, S. B. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim.; 27: No. 1, 191-4(Jan 1972). (In Russian).

Zirconium and hafnium are capable of forming complex compounds with benzoic acid and rhodamine B that can be extracted with benzene. The ratio of metal: benzoic acid: rhodamine B in the complex is 1:3:1. A photometric method is suggested for determining zirconium in the presence of hafnium after masking the latter with sodium fluoride. The sensitivity of the method is 0.3% of ZrO_2 in a mixture of zirconium and hafnium oxides. (auth)

27790 POTENTIOMETRIC DETERMINATION OF ZIRCONIUM WITH CUPFERRON. Ivanova, Z. I.; Rivina, V. Ya. (Rostov State Univ., USSR). Zh. Anal. Khim.; 27: No. 1, 189-91 (Jan 1972). (In Russian).

Conditions were studied for the potentiometric determination of zirconium with cupferron using a gold indicator electrode. The effect of the medium acidity, dilution, and the presence of some foreign ions on the accuracy of the determination was examined. The method was tested on the synthetic mixture Zircaloy. The results obtained are satisfactory. (auth)

27791 WIDENING THE CONCENTRATION RANGE DURING THE DETERMINATION OF IONS BY A PEAK CHROMATOGRAPHY METHOD. Aleskovskaya, V. N.; Aleskovskii, V. B. (Leningrad Inst. of the Textile and Light Industry). Zh. Anal. Khim.; 27: No. 1, 44-7(Jan 1972). (In Russian).

The method of peak chromatography permits determination in a sample of 1.0 to 300 μg of chlorine ions, 0.5 to 800 μg of iodine ions, 1 to 500 μg of bromine ions, and of a mixture of ions on paper impregnated with silver chloride. The possibility of determination and separation of halide ions on paper impregnated with silver suboxide was shown. The linear dependence of the peak height on the ion content in the sample and the possibility of regulating the peak height by changing the paper titer were confirmed. (auth)

27792 POTENTIOMETRIC DETERMINATION OF SMALL CONCENTRATIONS OF SUBSTANCES IN A FLOW CONCENTRATION CELL BY MEANS OF THE SECOND KIND ELECTRODES. Bardin, V. V.; Shartukov, O. F.; Tolstousov, V. N. (Leningrad Technological Inst.). Zh. Anal. Khim.; 27: No. 1, 25-30(Jan 1972). (In Russian).

An equation $\overline{C} = k_i \cdot \beta \cdot \Delta E$ is suggested for calculating the determined concentration $\overline{C}$ during the potentiometric determination of small concentrations of substances (Ag, Cl, Br, I, N, Pb, and SO_4^{2-}) in a flow concentration cell by means of the second kind electrodes. In this equation ΔE is the change of emf of the cell on replacement of the solution in the indicator cell that does not contain the determined ions by the analyzed solution; k_i is a proportionality coefficient determined by means of standard solutions; and β is a nonlinearity coefficient, its value corresponding to a given ΔE value is found from a graph. The method suggested for calculation permits the range of determined concentrations to be widened and the accuracy of the results to be increased. (auth)

27793 COMPARATIVE POTENTIOMETRIC STUDY OF COLOR REACTIONS OF SUBSTITUTED BISAZOCHROMOTROPIC ACID. Petrova, T. V.; Savvin, S. B.; Dzherayan, T. G. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 27: No. 1, 10-18(Jan 1972). (In Russian).

A potentiometric study was made of 19 reagents (substituted 2,7-bisazochromotropic acids) and their complexes with Ca, Ba, La, and Cu, which have three different types of color reactions. In reactions that take place at pH 8 to 10 one proton is liberated; that, apparently, is connected with the formation of the valence bond of the metal and the reagent by one of the hydroxyl groups in the naphthalene ring. In other reactions, taking place at pH 2 to 6, the liberation of one proton is observed only when the reagents have the COOH group in the ortho- position to the azo group. If there is no salt-forming substituent in the ortho-position to the azo group, color reactions proceed without the liberation of protons. (auth)

27794 PRECISION AND SOURCE OF VARIATION OF OXYGEN-TO-METAL DETERMINATIONS FOR $(U,Pu)O_2$. Lackey, W. J.; Bradley, R. A.; Pechin, W. H.; Hebble, T. L. (Oak Ridge National Lab., Tenn.). Nucl. Technol.; 14: No. 1, 105-8(Apr 1972).

With a statistically designed experiment it was demonstrated that gravimetric determinations of the oxygen-to-metal ratio of $(U,Pu)O_2$ depend strongly on the day of analysis, slightly on the particular sintering run, and not detectably on position in either the sintering furnace or the analysis furnace. The average oxygen-to-metal ratio of a single sintering run can be determined to a precision of ±0.005 at the 95% confidence level. (auth)

Radiometric and Radiochemical Procedures

Refer also to abstracts 27967, 27974, 28036, 28055, 28082, 28090, 28127, 28134, 28210, 28212, and 28677.

27795 (HASL-TM-71-1) THORON DETERMINATION BY THE TWO-FILTER METHOD. Thomas, Jess W. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Jan 1971. 26p. Dep. NTIS.

Studies were made of the validity and sensitivity of the two-filter method for determination of ^{220}Rn so that its usefulness for mine inspection and other work could be judged. (M.C.G.)

27796 (JUL-809-CT) NONDESTRUCTIVE BURNUP MEASUREMENTS ON SPHERICAL FUEL ELEMENTS BY USE OF GAMMA SPECTROSCOPY. Litzow, Werner (Kernforschungsanlage, Juelich (West Germany). Institut fuer Chemische Technologie). Nov 1971. 49p. (In German). Dep. NTIS (U. S. Sales Only).

Reprocessing of nuclear fuels demands a reliable mass balance of fissionable material, which requires exact knowledge about the burnup of individual fuel elements. A nondestructive burnup determination on spherical fuel elements with γ spectrometry is described. By means of a high-resolution Ge(Li) semiconductor detector, the 662-keV γ line of ^{137}Cs was utilized. All error sources connected with the procedure were analyzed to obtain the accuracy of the method. In addition, concentrations of other nuclides were studied from the γ spectrum. These may be of interest to special problems in various reprocessing phases.

Under consideration of all error sources and under present conditions, γ spectrometry yields an accuracy of burnup determination not better than ± 5%. (tr-auth)

27797 (STI/PUB-289) RAPID METHODS FOR MEASURING RADIOACTIVITY IN THE ENVIRONMENT. Proceedings Series. Proceedings of the International Symposium Held at Neuherberg, Germany, July 5–9, 1971. (International Atomic Energy Agency, Vienna (Austria)). Dec 1971. 980p. (In several languages). (CONF-710705). IAEA $25.00.

Seventy-six papers are included, of which sixty-four were abstracted individually for NSA. Twelve of the papers appeared previously in NSA. For abstracts of these papers see Conf. 710705 in the Report Number Index. (J.G.B.)

For abstracts of individual papers see: 27733, 27734, 27779, 27801–27828, 27854–27856, 27929, 28046, 28050–28060, 28069–28072, 28081, 28082, 28090, 28144, 28145, 28186, 28187, 28229–28232, 28286, and 28287.

27798 LIQUID SCINTILLATION ASSAY OF ^{3}H-LABELED PROTEIN IN RABBIT LENS. Gerweck, L. E.; Hendee, W. R.; Paterson, C. A. (Univ. of Colorado, Denver). Int. J. Appl. Radiat. Isotop.; 23: No. 4, 203-4(Apr 1972).

For radioactive tracer studies involving the rabbit lens where combustion techniques for preparation of counting samples are not feasible, solubilization of the labeled lens protein with Hyamine hydroxide and water or with NCS and water is an acceptable alternate procedure. (auth)

27799 NEW METHOD OF ^{90}Sr (^{89}Sr) DETERMINATION SUITABLE FOR MULTIPLE TESTING OF WATER AND URINE. Gyarmati, Laszlo. Honvedorvos; 23: No. 3, 230-8(Jul-Sep 1971). (In Hungarian).

A new and simple procedure for determining ^{90}Sr in urine and water was developed. The procedure is based on a good recovery of Sr by precipitation from water or urine as the sulfate in the presence of EDTA. The accuracy of the method was verified statistically as being equivalent to the reliability of the customary procedures. The sensitivity of the method is sufficient for the determination of the maximum allowable concentration of activity in urine or water with assurance. The procedure may be conducted without special preparation such as concentration of the sample, and without special equipment or chemicals other than found in any isotopes laboratory. (tr-auth)

27800 UTILIZATION OF THE PHENOMENON OF β-RADIATIONS BACK-DIFFUSION IN ANALYZING SOLUTIONS. Marcu, Gheorghe; Rusu, Mariana. Stud. Univ. Babes-Bolyai, Ser. Chem.; 16: No. 2, 121-6(1971). (In Rumanian).

The general theoretical considerations on analyzing solutions by back-diffusion of radiation are presented. The possibility of determining the potassium hexacyanoferrates and hexacyanoferrites in solution on the basis of this method was studied. The results establish a linear dependence between the intensity of the back-diffused β particles and the concentration of these solutions. The determination error is between ±0.86 and ±0.61% for the solutions containing 29.25 to 157.96 g $K_4[Fe(CN)_6]/1$ and between ±0.57 and ±0.46% for solutions containing 31.53 to 110.51 g $K_3[Fe(CN)_6]/1$. (auth)

27801 NEEDS AND PROGRESS IN RAPID ANALYSIS OF ENVIRONMENTAL SAMPLES. Harley, J. H. (Atomic Energy Commission, New York). pp 23-31 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

The need for the development of methods for the rapid determination of individual nuclides in the environment and in the food chain leading to man is discussed. The requirement for speed in analysis is based more on the need for handling large numbers of samples at reasonable cost rather than the need for producing data in a matter of hours. Under normal operating conditions the concentrations of radioactivity are extremely low and large samples are required. A rapid method then must emphasize ease in sample preparation and measurement of specific nuclides with as little chemical separation as possible. These considerations tend to make gamma spectrometry the method of choice, with the possibility of using in situ measurements as well as laboratory analyses. Present instrumentation has sufficient spectral resolution and it is hoped that increases in detector size and sensitivity will be forthcoming. Chemical separations are still required for alpha and beta emitters. Progress here has been slow, and there is no reason to expect a major breakthrough. (auth)

27802 RAPID DRY ASHING OF FOODSTUFFS. Boppel, B. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). pp 71-83 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

The monitoring of foodstuffs with respect to radioactivity and to contamination by trace metals (e.g., lead) requires in many cases previous ashing of the samples. In the method applied here for dry ashing, the most efficient experimental conditions were established with special emphasis on the time required. It is possible to ash, for example, a 500 g sample of food in a relatively short time (30 to 90 min, depending on the material) at about 500°C. Water-containing food (fruits, vegetables, etc.) as well as liquid food (milk, fruit juices, etc.) can be ashed in the specified time, requiring no previous drying procedures. Interactions previously observed between the moist and liquid foodstuffs and the special steel ashing apparatus during the ashing could be avoided by using appropriate inert layers. The temperature increase of the samples generated by oxidation processes was measured by immersed thermocouples and registered by a multichannel recorder. Because of the volatility of certain inorganic constituents, knowledge of the temperature change in the ashing sample is important. The degree of volatility of some fallout radionuclides was determined. The influence of the ashing temperature on the acid solubility of some fallout nuclides was also measured. From the 12 elements investigated, only the Ru/Rh isotopes exhibited a pronounced dependence of the acid solubility on the ashing temperature. (auth)

27803 RAPID RADIOACTIVITY CONTROL OF A GASEOUS ENVIRONMENT BY CHROMATOGRAPHY. Charrier, G.; Dupuis, Marie-Claire; Lutz, M.; Massimino, D. (CEA, Montrouge, France). pp 101-17 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In French).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

Gas chromatography combined with radioactivity detection provides a self-contained, rapid and selective method for the separation and measurement of stable and radioactive components of gaseous samples. Analysis is conducted batchwise, but the optimization of the separation times that has been achieved ensures a high rate of analysis. The components of a gaseous sample can be separated in less than one minute (tests carried out on air and mixtures of rare gases). The injection system used permits operation with sample volumes ranging from 10^{-2} to 20 cm^3. The separation of the components, which is generally carried out by gas-solid chromatography on normal absorbents, is followed by a double detection procedure. A thermal conductivity cell allows the measurement of stable gases down to microliter amounts. The detection of radioactive gases is carried out in an ionization chamber, a Geiger-Müller counter, or a scintillation counter. The minimum detectable activity is a few disintegrations per second for each radioisotope and is not affected by the activity of the other components of the mixture. The method is applied to gases of various compositions (air, helium, argon, carbon dioxide) and ensures the reliable determination of the separated elements. In order to avoid a long delay between separation and the availability of the results because of the time taken to evaluate the signals from the detectors a system for receiving the processing data from several units operating simultaneously was devised. The system, which includes a small computer, operates in real time and allows control of the sample introduction systems. The relative accuracy of analysis is, on the average, a few per cent. Where the concentrations of the desired components are too low, various preconcentration methods (preparative gas chromatography or selective absorption with pre-programmed temperature) can be applied. A system such as that described permits the rapid, simple, reliable, and quasi-continuous control of a gaseous medium for the detection of any radioactive contamination. (auth)

27804 RAPID AND SIMPLE DETERMINATION OF ^{59}Fe, ^{60}Co, ^{65}Zn, ^{137}Cs, AND ^{95}Zr IN CONCENTRATED SALT SOLUTIONS. Kawamura, S.; Shibata, S.; Kurotaki, K. (National Inst. of Radiological Sciences, Chiba, Japan). pp 119-29 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

Inorganic ion-exchange chromatography was combined with a Ge(Li) detector to determine ^{59}Fe, ^{60}Co, ^{65}Zn, ^{95}Zr, and ^{137}Cs in seawater rapidly. One liter of seawater (with hydrochloric acid

to make 0.1Ml) spiked with ^{59}Fe, ^{60}Co, ^{65}Zn, ^{95}Zr, ^{137}Cs, ^{85}Sr, ^{106}Ru, and ^{144}Ce (each about 2 μCi) was passed through a zirconium ferrocyanide (ZrFe) column (100 to 200 mesh, 1.5 × 5 cm) at a flow rate of 0.2 liter/h. ZrFe was dissolved with 60 ml of 25% EDTA · 4 Na solution, followed by evaporation of the aliquot. By measuring the radioactivity of each nuclide with the Ge·Li) detector, it was found that recoveries of 95.3, 95.1, 95.4, 97.5, 94.9, 0.9, 1.8, and 2.2 were achieved for ^{59}Fe, ^{60}Co, ^{65}Zn, ^{95}Zr, ^{137}Cs, ^{85}Sr, ^{106}Ru, and ^{144}Ce, respectively. The method is applicable to the determination of ^{59}Fe, ^{60}Co, ^{65}Zn, ^{95}Zr, and ^{137}Cs in 1 liter of seawater. The time for complete operation was from 7 to 8 h. When sodium zinc ferrocyanide combined with a zirconium ferrocyanide (NaZnFe · ZrFe) column (100 to 200 mesh, 1.5 × 5 cm) was used at a flow rate of 0.7 liter/h, recoveries were found to be 95.7, 95.6, 95.0, 64.1, 96.8, 0.9, 1.6, and 1.1% for ^{59}Fe, ^{60}Co, ^{65}Zn, ^{95}Zr, ^{137}Cs, ^{85}Sr, ^{106}Ru, and ^{144}Ce respectively. The operation may be completed in 2.5 or 3h. Therefore, apart from ^{95}Zr, the method is more rapid than the ZrFe method and recommendable for determining ^{59}Fe, ^{60}Co, ^{65}Zn, and ^{137}Cs. Chemical properties, adsorption rates for radionuclides, distribution coefficients in concentrated salts solution and the ion exchange behavior of ZrFe are described. (auth)

27805 RAPID SEPARATION OF NATURAL RADIONUCLIDES BY PAPER ELECTROMIGRATION AND DETECTION OF THE ALPHA EMITTERS BASED ON ALPHA PARTICLE TRACKING. Iwata, S. (Kyoto Univ.); Hashimoto, T.; Nishiwaki, Y. pp 151-6 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

Natural radionuclides, such as ^{227}Ac, ^{228}Ra, and their daughter nuclides, were subjected to rapid chemical separation by paper electromigration. The substances containing about 1μCi radionuclides were migrated for 3 min under a potential gradient of 2000 volt 29 cm on paper dipped with background electrolyte of 0.1 M ammonium formate. The detection of alpha radionuclides on this strip was carried out using the alpha particle track detector with celluloid film. Alpha-irradiated films were etched in 6N NaOH at 50°C for 15 min and compared with the autoradiographs on x-ray films. Thus the alpha nuclides could be easily distinguished from the beta and gamma nuclides. The decay and growth of alpha tracking after separation were used for identification of alpha-emitting nuclides on the strip. The half-life of the nuclide also could be confirmed from measurements of the number of alpha tracks obtained from the microscopic observation. The method is useful for the chemical investigation of alpha radionuclides, such as natural radionuclides and actinide elements. (auth)

27806 RAPID METHOD FOR DETERMINING ^{85}Kr IN ENVIRONMENTAL AIR SAMPLES. Cummings, S. L.; Shearin, R. L.; Porter, C. R. (Eastern Environmental Radiation Lab., Montgomery, Ala.). pp 163-9 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

A rapid method for determining ^{85}Kr in environmental air samples was developed. Equipment and procedure used to separate ^{85}Kr from environmental air samples for liquid scintillation counting are described in detail. The procedure employs charcoal and molecular sieve cold traps, calcium sulfate, ascarite (NaOH preparation), and a titanium furnace (900°C) for the removal and separation of other air constituents from krypton. Air samples are spiked with ^{83m}Kr to provide a direct determination of the krypton separation yield. This feature eliminates the need for expensive analytical equipment, such as a mass spectrograph for determining the purity of the final separation and the uncertainty in measuring krypton volumetrically when small amounts of other gases are present. The design of this system also eliminates the need for copper, cupric oxide, and lithium furnaces which have been used in other krypton separation systems. The system components are essentially all metal, thus eliminating many of the breakage problems encountered with glass systems. One cubic meter of air can be processed in about 4 h with 80 to 90% krypton recovery resulting in a 2-sigma error of the ^{85}Kr concentration of less than 10%. The processing time can be reduced if lower krypton recoveries can be tolerated. The procedure is well suited to monitoring environmental air samples with respect to nuclear facilities, such as nuclear reactors and fuel reprocessing plants. (auth)

27807 DETERMINATION OF PLUTONIUM IN ENVIRONMENTAL SAMPLES. Sakanoue, M.; Nakaura, M.; Imai, T. (Kanazawa Univ., Japan). pp 171-81 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

A simple solvent extraction method for determining plutonium in environmental samples was developed and applied to various samples, including soil from the Nagasaki area subjected to the first plutonium atomic bomb explosion in 1945, corals from the east Pacific Ocean coast, and seawater from the Pacific Ocean. As yield tracer, the alpha emitter ^{236}Pu (5.75-MeV) was first spiked into the sample, and the sample solution was prepared in 8M nitric acid solution either by direct leaching of the sample with nitric acid or by dissolving the ferric hydroxide precipitate made from the acidic solution of solid samples or natural water. Solvent extraction with trioctylamine was applied to this aqueous solution and followed by the scrubbing of uranium and thorium with 8M HNO_3 and 10M HCl, respectively. Finally, plutonium was stripped with 8M HCl + 0.2M HF, and determined by alpha spectrometry using a counting source prepared by electrodeposition on either a stainless steel plate or nickel foil. In addition to a gross alpha-track counting on cellulose nitrate, the very sensitive fission track method was also examined for determining ^{239}Pu and the evaluation of the interference from the contaminating uranium was studied. Contamination of the natural environment with plutonium isotopes was found in various samples, and the contents of each isotope were determined. (auth)

27808 DETERMINATION OF PLUTONIUM IN ENVIRONMENTAL SURVEILLANCE SAMPLES. Schuettelkopf, H. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). pp 183-97 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

Because of the large number of samples to be investigated for ^{239}Pu within the environmental surveillance program, a new analytical procedure was developed. It offers a considerable saving in time. About 5½ h are needed for the working operation from the disintegration solution to the processed sample. Eight to ten analyses can be performed by the operator daily. The analytical procedure consists of the separation of plutonium by co-precipitation with lanthanum fluoride and subsequent extraction by TTA–benzene solution. The reduction of PuO_2^{2+} to Pu^{3+} by the weak reduction reagent hydroxylamine was substituted by a reduction with Ti^{3+}. The time requirement of 3 to 15 h was thus reduced to minutes for the reduction step. The subsequent precipitation and extraction using TTA–benzene were optimized; each single step has important decontamination functions, high yields, and can be performed rapidly. The subsequent re-extraction yields a nitric acid solution, which, after boiling down, can be used for the gross alpha measurement of ^{239}Pu. So as not to dispense with the advantages of alpha spectrometry, a procedure for the electrolytic deposition and isolation of ^{239}Pu on special steel planchets was developed. For the purpose of purification, the ^{239}Pu solution is passed through an anion exchanger before electrolysis. The volumes of the washings and of the eluate were optimized. The electrolytic deposition proceeds quantitatively. The addition of ^{236}Pu to the samples enables reference analyses to be dispensed with. A considerable improvement in the mean error of the single results was achieved. The analytical procedure described gives a yield of about 80%, if all single steps for the samples mentioned are optimized. Interferences by the high potassium content of plant ashes and by the fairly considerable manganese content of fir needles were removed. The purification of the lanthanum carrier and the preparation and purification of ^{236}Pu are described. The decontamination factors for polonium, radium, thorium, and americium are reported. After a corresponding disintegration, the procedure can be applied to all environmental surveillance samples (vegetation, mud, plankton samples, evaporated precipitates, dust filters). (auth)

27809 RAPID IDENTIFICATION AND DETERMINATION OF ALPHA EMITTERS IN ENVIRONMENTAL SAMPLES. Sill, C. W.; Williams, R. L. (Atomic Energy Commission, Idaho Falls, Idaho). pp 201-11 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

Of all radioactive nuclides, long-lived alpha emitters have the lowest permissible levels in environmental samples. Their rapid identification and determination in air dusts, smears, water, and sediments are of considerable importance, particularly in emer-

gencies, so that their impact on the public health can be assessed and remedial action begun without delay. For the immediate post-incident investigation, when time is of prime importance, direct alpha spectrometry on samples collected and counted for short periods is clearly indicated. Even though badly degraded from the absorber invariably present, alpha spectra permit positive and unequivocal identification in most cases if the intercept of the high-energy edge with the energy co-ordinate is used to determine the energy. Quantitative estimates can also be obtained. When chemical separations become necessary or desirable, the sample is ashed, fused with potassium fluoride, and transposed to a pyrosulfate fusion. The resultant cake dissolves completely in water from which small quantities of all alpha-emitting elements from lead through californium, except astatine, radon, and francium, can be precipitated simultaneously on barium sulfate. The barium sulfate is then reprecipitated from an alkaline solution of diethylenetriaminepentaacetic acid with acetic acid leaving all alpha-emitting elements except radium in the filtrate. After wet-ashing and electrodeposition, each component can be identified by alpha spectrometry with very few mutual interferences. The entire chemical procedure requires less than three hours. With a counting time of only 10 minutes, the following detection limits can be achieved with a clean detector: 5×10^{-7} μCi on smears, 1×10^{-5} μCi/g on 50-mg sediment samples, 5×10^{-6} μCi/ml on 10-ml water samples, and 2×10^{-12} μCi/ml on 10-min air samples collected at 1 ft^3/min. These sensitivities are more than adequate for emergency use, the later two values being only 0.1 and 100 times, respectively, the levels permitted in uncontrolled areas for continuous exposure to the worst possible case, ^{248}Cm. On the other hand, when time permits, a 10^3 min spectrum on a 10^3 m^3 air sample permits easy measurement of artificial nuclides present in the atmosphere at concentrations above 5 aCi/m^3. (auth)

27810 DETERMINATION OF URANIUM IN BIOLOGICAL MATERIALS BY THE FISSION-TRACK METHOD. Wiechen, A. (Bundesanstalt fuer Milchforschung, Kiel). pp 213-16 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

The uranium content of biological materials was determined by the fission-track technique, introduced for geological dating and for determining uranium in minerals, glass, and metallurgical materials. Biological materials, such as milk, whole blood, and grass, were dry-ashed and the ashes ground and homogenized. Forty mg of each sample were pressed into pellets and fixed to a polycarbonate foil. After 2 min of irradiation at a thermal flux of 10^{13} $n/cm^2 \cdot sec$ the polycarbonate sheets were detached and etched with 6 N NaOH at 45°C for 1 h. The fission tracks obtained were counted by means of a microscope. Standards were prepared, irradiated, and etched in the same manner and at the same time. The detection limit is about 1 ppB referring to the wet matter of the biological materials. A previous chemical enrichment of the uranium by coprecipitation with Prussian Blue results in a lowering of the detection limit to about 0.1 ppB. The fission track technique is a convenient and simple method for determining uranium in environmental materials. At the same time a large number of samples may be irradiated, thus lowering the cost to the minimum. (auth)

27811 RAPID DETERMINATION OF LOW-LEVEL ALPHA- AND BETA ACTIVITIES IN BIOLOGICAL MATERIAL USING WET ASHING BY -OH RADICALS. Sansoni, B.; Kracke, W. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Neuherberg, Ger.). pp 217-31 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

A method for the rapid dissolution of organic material by Fenton's reagent, H_2O_2/Fe^{2+} without complete ashing, radiochemical concentration and separation by ion exchange, and beta measurement or alpha spectrometry is described. The method is well suited for routine work with large sample numbers. In the determination of ^{137}Cs samples of 100 g meat or fish were dissolved within 45 min. Fat has to be removed mechanically or by extraction with trichloroethylene. ^{137}Cs is separated on the ion exchanger $(NH_4)_2[Fe,Co(CN)_6]$. Subsequently, its beta activity can be measured directly. For routine work the determination needs about 2 to 3 h. The radiochemical yield is about 75%, the lower detection limit 6 pCi ^{137}Cs/kg wet weight. In the determination of ^{210}Po, 1.5-kg samples of meat are ashed completely after addition of Hg^{2+} carrier and ^{208}Po as tracer. Polonium is separated by coprecipitation with HgS. This is dissolved in HNO_3–HCl and Hg + Po are deposited on a copper disc. Metallic Hg sublimes at 40°C under water jet vacuum. The latter permits a calculation of the radiochemical yield, which is between 50 and 70%. The lower limit of detection is 0.1 pCi ^{210}Po/kg. In routine work the determination takes 72 h. (auth)

27812 RAPID AND COMPLETE RADIOBIOLOGICAL ANALYSIS OF MILK. Morre, J.; Janin-Caufment, F.; Mazer, J. P. (Ministere de l'Agriculture, Paris). pp 233-9 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In French).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

The analysis was carried out using conventional chemical methods only, with the exception of the adsorption of iodine on a resin at the beginning of the procedure. The milk is coagulated, the alkaline earths are precipitated by ammonium oxalate, and cesium is measured directly in the filtrate. Calcium is removed, barium is precipitated, and, after removal of yttrium by ammonium hydroxide, strontium carbonate is obtained. Unique features of the method are coagulation of the milk by addition of crystalline trichloroacetic acid; separation of calcium from strontium by nitric acid and an alcohol–ether mixture, determination of the optimum pH value for the barium chromate precipitation by yield measurements with ^{133}Ba and ^{85}Sr tracers, modification of the low background beta counter RA 15 Intertechnique in order to separate ^{89}Sr and ^{90}Sr, and the results drawn on semi-logarithmic paper, on which the slopes of the straight lines have been previously determined. For the complete analysis of 250 ml milk, a maximum of 6 h are needed. (auth)

27813 RAPID SEPARATION AND DETERMINATION OF RADIONUCLIDES IN ASHES OF FOODSTUFFS. Boppel, B. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). pp 241-7 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

For rapid analytical separations of radionuclides in food ashes extraction chromatography with organic reagents in the liquid phase is one of the most efficient methods, since these separations can be performed in a few minutes, are usually quantitative, and exhibit high decontamination factors. Separation procedures that meet these requirements and can be varied depending on special conditions have been evaluated for the radionuclides ^{137}Cs, ^{140}Ba–^{140}La, ^{89}Sr, and ^{90}Sr–^{90}Y, ^{141}Ce, and ^{144}Ce–^{144}Pr, ^{95}Zr–^{95}Nb, ^{103}Ru–^{103m}Rh, and ^{106}Ru–^{106}Rh, ^{125}Sb, and ^{40}K in food ashes. Furthermore, the selective extraction of beta emitters (e.g., ^{90}Sr and ^{90}Y) from food ashes is advantageous, since the organic phases thus obtained can be measured without further handling in a liquid scintillation spectrometer. Since in these cases the counting efficiency is almost 100%, only a correspondingly short measuring time is necessary. Depending on the activity, it amounts to 10 to 50 min. If all standard conditions, to be established in advance, are met, evaluation of the results can be performed in 1 min. (auth)

27814 AUTOMATIC LIQUID-PHASE RADIOANALYSER: THE APPLICATION OF SUBSTOICHIOMETRIC SOLVENT EXTRACTION AND DISPLACEMENT ON ION-EXCHANGE RESINS FOR THE RAPID ANALYSIS OF RADIOACTIVE ELEMENTS BY ISOTOPIC DILUTION. Colomer, J.; Cousigne, M.; Metzger, G. (CEA, Montrouge, France). pp 249-61 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In French).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

A method of liquid-phase automatic analysis is described which permits the determination of one or more radioactive elements in the course of their isolation. In the analytical procedure use is made of the principle of isotopic dilution with a stable carrier in combination either with substoichiometric solvent extraction or with the spread of the radioactive elements on ion-exchange resins by displacement at constant concentration. The radioactivity measurement is carried out by means of Cherenkov counting. It is carried out on-line and is applied alternately to the isolated elements and to standards treated under the same operating conditions. The method was used for the determination of ^{99}Mo, ^{89}Sr, and ^{140}Ba in fission products. It has the advantage of simplicity and automatic operation and of greater speed and reliability than classical radiochemical methods. The accuracy of the results depends largely on the accuracy of the activity standard. The procedure can also be used, with the same detector, for the treatment

of several samples simultaneously, a number of results being obtained for each which can be stored on punched tapes and evaluated automatically by computer. The possibilities of applying this method to other radioactive elements are discussed. (auth)

27815 MONITORING OF TRITIUM UNDER EMERGENCY CONDITIONS. Moghissi, A. A.; Bretthauer, E. W.; Carter, M. W. (Western Environmental Research Lab., Las Vegas, Nev.). pp 263-6 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

Tritium monitoring following an inadvertent release subsequent to a nuclear detonation or a reactor accident may require purification of the collected water. The method described consists of a separation of the major interfering radionuclides from the water samples by coprecipitation with silver chloride and iron- hexacyanoferrate followed by a conventional distillation. It is demonstrated that this technique effectively removes volatile radionuclides such as radioiodine. The tritium activity of the water is then determined by liquid scintillation. Several new liquid scintillation mixtures are evaluated for this purpose. In particular, the effect of naphthalene and 2,5-bis-2-(5-tert-butylbenzoxazolyl)-thiophene (BBOT) on the performance of Triton N-101–p-xylene and other cocktails was evaluated and the results are discussed. (auth)

27816 SIMPLE APPLICATION OF LEAST-SQUARES FITTING TO GAMMA SPECTROMETRY OF MARINE ENVIRONMENTAL SAMPLES: THE CASE OF CESIUM RADIONUCLIDES. Fukai, R. (International Atomic Energy Agency, Monaco); Ballestra, S.; Rapaire, J. L. pp 301-10 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

A simple least-squares fitting procedure, using a small electronic computer, was successfully applied to the problem of resolving superimposed peaks in the gamma spectra of ^{134}Cs and ^{137}Cs. With the aid of rapid radiochemical separation procedures, interfering radionuclides were eliminated sufficiently for accurate determination by gamma spectrometry. The procedures used and limiting conditions for the application of this technique to marine environmental samples are described and discussed in detail. With a prolonged counting time and the application of statistical smoothing technique for the recorded spectrogram the lower limit of quantitative measurements on mixtures of ^{134}Cs and ^{137}Cs was found to be about 1 pCi of each radionuclide with an associated error of ±20%. (auth)

27817 RAPID DETERMINATION OF GAMMA-RAY EMITTING RADIONUCLIDES IN WATERS. Arndt, J.; Wolter, R. (Bundesgesundheitsamtes, Berlin). pp 311-18 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

Waste waters of four German nuclear power plants were investigated to determine their content in radioactive substances in order to obtain a balance of the different radionuclides released to the environment. Since in general these waters contained radionuclides only in small concentrations, the radioactive substances from the waste waters were enriched by sorption on the ion exchanger Lewasorb. The determination of the different gamma-emitting radionuclides was achieved by gamma spectrometric investigations by means of a semiconductor detector and a 4000-channel analyzer. With an enrichment of the radionuclides from 2 liters of water on 50 ml of Lewasorb, the minimum detectable activity amounts to 10^{-8} μCi/ml, when a detector with a sensitive volume of 28 cm^3 and a counting time of 1 h is used for radionuclides, showing a transition probability of 1. The gamma spectrum obtained is registered on punched tape and evaluated by a computer. The computer program includes location, integration, and determination of the gamma energy of the peaks, conversion of the pulse rates in preliminary activities, identification of the peaks, and computation of the activities of the different radionuclides, as well as conversion of the activities in radionuclide concentrations. Since the counting time can be lowered without difficulty to only a few minutes by using larger water samples, the procedure is particularly suitable as a rapid method in emergency situations. The procedure permits a complete analysis of gamma-emitting radionuclides within 30 min. (auth)

27818 ANALYTICAL METHODS IN GAMMA SPECTROSCOPY WITH EXAMPLES FOR APPLICATION. Winiger, P.; Huber, O.; Halter, J. (Univ., Fribourg, Switzerland). pp 319-37 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

In emergency situations, gamma spectrometers with NaI crystals and Ge(Li) detectors offer clear advantages for a rapid and reliable identification and activity determination of gamma emitters. For the evaluation of the measured spectra, depending on the urgency and the accuracy required, optical, graphic, and digital data registration is applied, providing a complete examination of the analyses. Considerable progress has been made in digital data handling, which can be used for the localization, energy, and intensity determination of the lines as well as for their identification by using a table of gamma transitions. Complete calculation of the activity of the gamma emitter in the sample is thus possible. The analytical representation of the required counting efficiency of the detector by only a few parameters is particularly important when working in on-line operation with small computers. Likewise, in the data handling of spectra obtained from larger computers, where the spectrum has to be transferred to a magnetic tape or punch cards, it offers a considerable improvement compared with a tabular registration: flexible programming and economic manual data preparation. For the representation of the photopeak efficiency the following equation holds: $a(E) = a(E_0)/2\,[(E/E_0)^{\alpha} + (E/E_0)^{\beta}]\,[1 - \exp(\gamma \cdot E)]^{\delta}$. This function describes the experimental values $\alpha(E_K)$ of the calibration lines E_K of our 3 cm^3 Ge(Li) detector with an accuracy of ±5%, when appropriate parameters E_0, α, β, γ, δ are selected in the energy range 30 to 5000 keV with different geometric arrangements. The same type of function can also be applied for the efficiency curves of NaI crystals. As an example of the data handling described, gamma spectra are used of samples obtained during the reactor incident in Lucens on Jan. 21, 1969. (auth)

27819 RAPID EVALUATION OF RADIOACTIVE SAMPLES BY GAMMA-RAY SPECTROMETRY. Salmon, L.; Toureau, A. E. R. (Atomic Energy Research Establishment, Harwell, Eng.). pp 339-55 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

Gamma spectrometry provides a convenient and relatively rapid means of performing instrumental radiochemical analysis. The technique is used regularly at Harwell to estimate hazards following any incident believed to involve the escape of radioactivity. Spectrometry may also be used for more routine monitoring of radioactivity not only in the neighborhood of nuclear establishment but of the environment in general. Various forms of gamma spectrometry are described briefly with examples of applications to local environmental monitoring. Since numerical methods of analysis are used the appropriate data handling problems are discussed. (auth)

27820 DETERMINATION OF ENVIRONMENTAL RADIOACTIVITY BY LIQUID-SCINTILLATION SPECTROMETRY. Prochazka, H.; Jilek, R. (Inst. of Veterinary Medical Research, Brno). pp 373-80 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

A liquid-scintillation spectrometer was used for measuring environmental radioactivity induced either by fallout nuclides or by naturally occurring radioactive elements. The resolution of ^{59}Fe, ^{60}Co, ^{90}Sr, ^{90}Y, ^{103}Rh, ^{137}Cs, ^{147}Pm, ^{210}Po, ^{210}Pb, ^{210}Bi, ^{226}Ra with its short-lived daughter products, and natural uranium can be accomplished spectrometrically under the conditions described. The sensitivity of the method presented is better than 1×10^{-12} Ci/l per ml or g of the sample. Differential relative counting efficiency for all these nuclides is better than 70% with a background 20 ± 10 counts/min. An example of qualitative and quantitative determination of the nuclides examined is presented together with basic mathematical principles of their calculation. The rapid method described is suitable for measuring radioactively contaminated waters as well as biological samples. (auth)

27821 APPLICATION OF LIQUID SCINTILLATION SPECTROMETRY FOR TOTAL BETA AND ALPHA ASSAY. Bogen,

D. C.; Welford, G. A. (Atomic Energy Commission, New York). pp 383-9 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

Total beta and alpha measurements were performed, simultaneously, by liquid scintillation spectrometry. The beta measurement classifies the isotopes by energy discrimination into two categories: low-energy (^{3}H, etc.) and fission products or activation products of medium-to-high energy. The alpha measurement is performed by ratio techniques since the alpha spectrum is located in the medium-to-high-energy beta spectral region. Therefore, one measurement provides the following information for an environmental sample: relative contribution of tritium and other low-energy emitters to the total beta spectrum; contribution of fission and activation products to the total beta spectrum; and total alpha activity. The approximate detection limits would be 0.6 dpm/ml for low-energy beta, 0.3 dpm/ml for high-energy beta, and 0.1 dpm/ml for alpha. Assumed as the limit was one sigma background error, a 100 min counting time, a 3 ml sample volume, and an alpha content of 10% of the total sample activity. A description of experimental results, data processing, application to environmental monitoring, and comparison of this technique to existing methods is given. (auth)

27822 RAPID LIQUID SCINTILLATION TECHNIQUE FOR MONITORING ^{14}C IN AIR. Moghissi, A. A.; McNelis, D. N.; Plott, W. F.; Carter, M. W. (Western Environmental Research Lab., Las Vegas, Nev.). pp 391-4 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

A new technique for liquid scintillation counting of ^{14}C was developed recently in this laboratory. This technique is based on absorption of carbon dioxide in cesium hydroxide and the subsequent suspension of the resulting carbonate in a p-xylene, Triton N-101, and sodium xylenesulfonate mixture. The application of this technique for the rapid monitoring of ^{14}C in the form of carbon dioxide in the air is described. Carbon dioxide is absorbed from the ambient air using a cesium hydroxide solution. Two aliquots of this solution are mixed with a scintillation cocktail consisting of xylene, detergents, and appropriate scintillators. The scintillation cocktail added to one of the aliquots contains a known amount of ^{14}C thus enabling the determination of the counting efficiency in the subsequent liquid scintillation counting of the aliquots. If a higher accuracy is desired, a third aliquot of cesium carbonate solution is used for the determination of carbon dioxide. The method is capable of detecting an increase of approximately 20% in the background ^{14}C levels if no interfering radionuclides are present in the air. (auth)

27823 MEASUREMENT OF SMALL AMOUNTS OF TRITRATED GAS: RADIATION PROTECTION APPLICATIONS. Zerbib, J.-C. (CEA-CEN, Saclay, France); Bonleu, M.; Imbert, L.; Mary, J. pp 395-404 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In French).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

A simple technique for the preparation of samples whereby gaseous tritium can be measured using any of the commercially available liquid scintillation spectrometers is proposed. In addition to anthracene (the classical solid scintillator), fluorescent plastic shavings and various scintillator geometries are used. Because of the need for a vacuum before filling, liquid scintillators cooled (by means of liquid nitrogen) until solid were used. Various methods are discussed, and the efficiencies achieved are found to be reasonable compared with those achieved with the liquid scintillation method. (auth)

27824 DETERMINATION OF NUCLIDES IN RADIOACTIVE FALL-OUT EMPLOYING A Ge(Li) DETECTOR. Weinreich, R. (Univ., Mainz). pp 405-16 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

More rapid and precise statements about the composition of fallout samples, collected shortly after nuclear tests, were obtained by using a Ge(Li) diode instead of a NaI(Tl) detector. The nuclide 12.8-d ^{140}Ba–^{140}La can be determined in fallout ashes nondestructively. The separation procedure for 66-h ^{99}Mo–^{99}Tc is essentially shortened. A simplified evaluation procedure is derived for the determination of 6.75-d ^{237}U and 2.35-d ^{239}Np. Furthermore, 53-d ^{7}Be is measured nondestructively. The measurement of ^{7}Be at different times enables a rapid determination to be made of its background in fallout. The concentration of ^{7}Be in fallout samples increased after the Chinese nuclear weapon test of Oct. 14, 1970. (auth)

27825 SIMPLE COMPUTER PROGRAM FOR THE RAPID EVALUATION OF PHOTOPEAKS IN GAMMA SPECTRA. Rohleder, H. A.; Kinder, L. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Neuherberg, Ger.). pp 417-25 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

A computer program was developed for evaluation of γ spectra using only computer-adjusted calculation procedures. The logarithm of the countings of the spectrum is taken and from this vector the difference scheme is established. Parallel with it, a second scheme of the corresponding variances is calculated as obtained from counting statistics. From both schemes all peaks with approximately Gaussian curve shape are easily identified. With the necessary weighting factors, their half-width values and the position of the peak maximum are calculated. For the identification at least three successive channels are needed from an arbitrary part of the peak. The user can select a value for the discriminator by which the peak shape is more or less critically examined. Calculation of the peak areas is now being studied. The program consists only of a few simple calculations and needs only small cores. The time for computation amounts on our ICL 1902 A to only some seconds. This is about $1/50$ to $1/200$ of the time necessary for a least-squares-fit program with standard spectra. (auth)

27826 MEASUREMENTS OF ^{89}Sr AND ^{90}Sr IN ENVIRONMENTAL SAMPLES BY A LOW-BACKGROUND BETA-RAY SPECTROMETER. Kamada, H.; Mita, M.; Saiki, M. (National Inst. of Radiological Sciences, Chiba, Japan). pp 427-39 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

The direct quantitative determination of ^{89}Sr and ^{90}Sr was successfully carried out by low-background beta spectrometry. According to this method, the ^{90}Y milking operation, which requires storage of $SrCO_3$ for two weeks after chemical separation from samples, could be omitted. Therefore, many samples could be analyzed more easily and quickly. An attempt to apply beta spectrometry to the survey of the fallout level radioactivity was made. The individual radioactivities of ^{89}Sr, ^{90}Sr, and ^{90}Y in the sample were calculated by the simultaneous equation method taking into consideration interference factors that express the fractional contribution of the selected regions of beta spectra due to ^{89}Sr, ^{90}Sr, and ^{90}Y. The amount of the individual nuclide on the composite ^{90}Sr + ^{90}Y + ^{89}Sr spectra, obtained by this method, agreed well with standard values. Errors from self-absorption were also corrected. The concentration of ^{90}Sr in soil samples determined by this method agreed well with conventional method results obtained by researchers. The data on various kinds of environmental samples determined by this method showed a detectable amount of ^{89}Sr. (auth)

27827 RAPID METHODS FOR SPECIFIC RADIONUCLIDE ANALYSIS AND THEIR APPLICATION TO AQUATIC EMERGENCY CONDITIONS. Dutton, J. W. R.; Mitchell, N. T. (Fisheries Radiobiological Lab., Lowestoft, Eng.). pp 745-55 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

A range of laboratory analytical methods in current use for controlled disposals of liquid radioactive waste is described, together with an account of procedures at successive stages of sample preparation, chemical separation (where necessary), radiometric measurement, and processing of data. They include both manual and automated procedures, using a range of detector systems, and are directed to estimation of specific radionuclides. In conclusion an account is given of how these methods would be applied in the event of an emergency and integrated with field measurement techniques. The way in which they would be adapted to overcome limitations

imposed by their operation outside controlled laboratory conditions is also considered. (auth)

27828 ESTIMATION OF THE ^{131}I CONCENTRATION FOLLOWING A RELEASE OF FRESH FISSION PRODUCTS. Funsch, B. (Landesinstitut fuer Arbeitsschutz und Arbeitsmedizin, Karlsruhe, Ger.). pp 779-95 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

When considering internal radiation exposure in the case of major reactor accidents, ^{131}I deserves special attention. Unfortunately, the determination of its concentration in the first hours after the release can prove very difficult since a large number of other fission products exists. Even high-resolution gamma spectrometry using a semiconductor detector is not always adequate. For this reason, if necessary, a rapid radiochemical iodine separation is carried out beforehand. If, because of the overlapping lines of other iodine isotopes, ^{131}I still cannot be directly determined quantitatively in the spectrometric investigation, an indirect evaluation using the theoretical $^{133}I/^{131}I$ ratio is proposed. The latter depends on the type of reactor as well as on the way the reactor was operated and should, therefore, be known approximately for each installation. As a basis it can be stated that the ratio of the saturation activities is, e.g., for thermal reactors, around 2.3. After the separation the gamma peak of ^{133}I at E_γ = 1.235 MeV (intensity 2%) is undisturbed and can be used for the measurement. Owing to the short half-life of ^{133}I (21 h), this procedure becomes the more inaccurate the longer the lapse of time from the incident; in this event, however, the ^{131}I can then be measured directly. Depending on the mode of release, the fastest possible information can be obtained successively in this way. (auth)

27829 GAMMA RAY SPECTROMETRY OF URANIUM SAMPLES. Ionescu, Constantza (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 6, 643-5(1971).

Some radioactive samples obtained by chemical separation of uranium ore were analyzed by γ spectrometry. The spectra were different from spectra of the ore. Only the γ peaks yielded by all uranium partners appearing up to ^{234}U were observed. ^{234}Th, ^{231}Th, ^{238}U, ^{235}U, ^{214}Pb, and ^{214}Bi were also identified in the samples. In all the samples ^{226}Ra was missing. (M.C.G.)

27830 YIELDS OF TRITIUM DURING FISSION OF NUCLIDES OF INTEREST IN NUCLEAR POWER REACTORS. Horrocks, Donald L. (Argonne National Lab., Ill.). Develop. Appl. Spectrosc.; 9: 403-15(1971).

From Developments in applied spectroscopy symposium; Chicago, Ill. (2 Jun 1970).

Many of the known values of the yields of tritium from fission of several nuclides are tabulated. The yields are plotted relative to the value of Z^2/A of the fissioning nucleus, where Z is the atomic number and A is the mass number. A brief discussion is given of the method of formation of the light particles during fission and their energy and angular distributions. Some of the problems of accurately measuring the tritium yields are discussed. (auth)

27831 RADIOMETRIC METHOD FOR THE ANALYSIS OF TWO-COMPONENT SYSTEMS WITH THE USE OF CALIBRATION CURVES. Shamaev, V. I. (Moscow Chemical-Technological Inst.). Zh. Anal. Khim.; 27: No. 1, 48-53(Jan 1972). (In Russian).

A radiometric method was developed for analysis of two-component systems with the use of calibration curves. The method allows the analysis of binary mixtures of elements similar in their properties to be carried out with reasonable accuracy. The method of calibration curves is based on the partial concentration or dilution of the labeled component by single-time precipitation, ion exchange, or extraction into the organic phase and on the comparison of the inter-phase distribution of the activity with a calibration curve constructed by means of the samples of the known composition. (auth)

27832 FUEL ROD ENRICHMENT DETERMINATION BY GAMMA-RAY SPECTROMETRY. Vaughn, A. D.; Smith, R. I. (Battelle-Northwest, Richland, Wash.). Nucl. Technol.; 14: No. 2, 146-52(May 1972).

The plutonium concentrations in mixed oxide fuel rods containing distinct sizes of particulate plutonium oxide have been determined using high-resolution gamma spectrometry. The fuel rod enrichments were in the range 2 to 2.5 wt% in natural UO_2. Individual rod enrichments were determined to within ±0.1 wt% by comparison with a known standard. Differences in plutonium isotopic composition were discernable also, in addition to the differences in plutonium enrichment. The technique provides an inexpensive nondestructive method of determining in situ plutonium composition and content of assembled fuel rods, for purposes of quality assurance and accountability control. (auth)

27833 MEASUREMENT OF THE ^{235}U CONTENT IN A SPENT MTR TYPE FUEL ELEMENT USING THE DELAYED-NEUTRON YIELD TECHNIQUE. Augustson, R. H.; Henry, C. N.; Weisbin, C. R. (Los Alamos Scientific Lab., N. Mex.). Nucl. Technol.; 14: No. 2, 197-9(May 1972).

The ^{235}U content of a spent MTR fuel element enclosed in a Pb transfer cask has been nondestructively measured by observing the delayed neutron emissions following high-energy neutron induced fission. Neutrons (14-MeV) from a (D, T) neutron generator moderated thru 8 in. of Pb were used as the interrogating radiation. A DTF-IV calculation was used to correct the data for the contributions due to other fissionable isotopes. The nondestructive measurement agreed with the ^{235}U content as predicted by reactor burnup calculations to within 1.5%. (auth)

Separation Procedures

Refer also to abstracts 27932, 27972, 27981–27984, 27991, 28276, and 28537.

27834 (INP-781) INFLUENCE OF HAMMETT'S COEFFICIENTS ON THE DISTRIBUTION RATIO OF LANTHANIDE AND TRANSPLUTONIDE ION-PAIRS WITH ALIQUAT-336. Stronski, Ignacy; Nahlik, Elzbieta (Institute of Nuclear Physics, Krakow (Poland)). Nov 1971. 16p. Dep. NTIS (U. S. Sales Only).

The dependence of the distribution ratio D on the Hammett coefficients by liquid–liquid extraction of the salts of europium, americium, and curium was investigated using tricaprylmethylammonium nitrate as extracting reagent. An inverse relationship of the values of log D and δ was found. (auth)

27835 (INR-P-1341) REGULARITIES IN THE FREE ENERGY CHANGES AND GENERAL TRENDS IN THE ENTHALPY AND ENTROPY TERMS FOR COMPLEXATION THE LANTHANIDE IONS WITH DIFFERENT LIGANDS. Fidelis, Irena (Institute of Nuclear Research, Warsaw (Poland)). 1971. 11p. (CONF-700540-2). Dep. NTIS (U. S. Sales Only).

From Polish-Italian seminar on some chemical, ceramic, and metallurgical aspects of nuclear fuels; Zakopane, Poland (29 May 1970).

Regularities, observed in the separation factor in many complexing systems, are discussed. Thermodynamic data for complexation of lanthanide ions with different ligands were surveyed. Data for simple carboxylic, α-hydroxy, and polyaminopolycarboxylic acid, and organophosphorus ligands are considered. Four basic trends in the enthalpy changes were distinguished. These trends seem to be connected with steric hindrances rather than with the chemical nature of coordinating ligands. (auth)

27836 (INR-P-1357) POSSIBILITIES OF APPLYING EXTRACTION CHROMATOGRAPHY FOR THE SEPARATION OF SOME FISSION PRODUCTS. Fidelis, Irena; Smulek, Wiktor (Institute of Nuclear Research, Warsaw (Poland)). 1971. 9p. (CONF-700540-3). Dep. NTIS (U. S. Sales Only).

From Polish-Italian seminar on some chemical, ceramic, and metallurgical aspects of nuclear fuels; Zakopane, Poland (29 May 1970).

Possibilities of applying extraction chromatography for the separation of some fission products are discussed. A list of papers (24) on extraction chromatography carried out in the Department of Radiochemistry of the Institute of Nuclear Research up to 1970 is presented. (auth)

27837 ION-EXCHANGE EQUILIBRIUM FOR UNIVALENT IONS ON PHOSPHONIC ACID ION-EXCHANGE RESINS. I. SODIUM–LITHIUM AND SODIUM–CESIUM ION EXCHANGE ISOTHERMS ON RF CATION-EXCHANGE RESIN. Korshunova, S. P.; Sharapova, N. P.; Chmutov, K. V. (Inst. of Physical Chemistry, Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 9, 1304-6(Sep 1971).

Translated from Zh. Fiz. Khim.; 45: No. 9, 2311-14(Sep 1971).

The sodium–lithium and sodium–cesium ion-exchange equilibria on the phosphonic acid RF ion-exchange resin were investigated over a wide range of saturations and pH of the equilibrium solutions. The selectivity coefficients were calculated from Barrer's equation. (auth)

27838 MECHANISM OF THE SORPTION OF METAL IONS BY PHOSPHONIC ACID CATION-EXCHANGE RESINS. Chuveleva, E. A.; Nazarov, P. P.; Chmutov, K. V. (Inst. of Physical Chemistry, Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 9, 1296-9(Sep 1971).

Translated from Zh. Fiz. Khim.; 45: No. 9, 2297-2301(Sep 1971).

The sorption of uranium, copper, and nickel by KRF phosphonic acid ion-exchange resins was investigated. The stability constants of the uranium, copper, and nickel complexes with the phosphonic acid groups of the resin were determined and an unusually high affinity of uranium for the phosphonic acid groups was noted. (auth)

27839 DETERMINATION OF EXTERNAL-DIFFUSION KINETIC COEFFICIENT FROM A DYNAMIC ION-EXCHANGE EXPERIMENT. Nikashina, V. A.; Rubinshtein, R. N. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 11, 1606-8(Nov 1971).

Translated from Zh. Fiz. Khim.; 45: No. 11, 2842-4(Nov 1971).

A method for calculating the kinetic coefficient from a dynamic experiment involves use of the solution to the problem of the dynamics of the sorption of a single substance controlled by external diffusion, together with the instantaneous breakthrough value. The dependence of the kinetic coefficient on the experimental parameters (rate of flow, grain-size of sorbent) is given. Data are included for Na, K, Rb, and Cs. (auth)

27840 CONCENTRATION OF TRACE AMOUNTS OF MOLYBDENUM AND VANADIUM FROM AQUEOUS AND SALT SOLUTIONS. Amelin, A. N.; Karyakin, Yu. V. (Voronezh Technological Inst., USSR). J. Appl. Chem. USSR (Engl. Transl.); 44: No. 9, 2130-1(Sep 1971).

Translated from Zh. Prikl. Khim.; 44: No. 9, 2098-9(Sep 1971).

Sorption of Mo and V on activated carbons was studied. Maximum sorption of Mo from ammonium molybdate solution containing 50 μg of Mo per ml was achieved at pH = 2.65 (95% the original amount on BAU carbon and on phosphated carbon). The optimal pH was 3.0 for a V solution initially containing 110 μg V per ml (the phosphated carbon sorbs 98% of the original V content and activated carbon 71%). (M.C.G.)

27841 POSSIBILITY OF A THEORETICAL CALCULATION OF ION-EXCHANGE EQUILIBRIUM CONSTANTS ON CATION EXCHANGERS. Kuznetsova, E. M. (Moscow State Univ.). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 10, 1460-1(Oct 1971).

Translated from Zh. Fiz. Khim.; 45: No. 10, 2581-3(Oct 1971).

A scheme, based on the concept of the electrostatic interaction of cations with the anion of the exchanger and the water dipole taking into account their polarizability, is proposed for the calculation of ion-exchange equilibrium constants for singly charged cations on a sulfonated resin. The exchange constants on Dowex 50 resin for the Na^+-LiR, K^+-NaR, Cs^+-NaR, Rb^+-KR, and Cs^+-RbR systems were calculated using the equation proposed. The calculated values agree satisfactorily with the experimental literature data. (auth)

27842 THEORETICAL CALCULATION OF ION-EXCHANGE EQUILIBRIUM CONSTANTS FOR SULPHONATED RESINS WITH DIFFERENT DIVINYLBENZENE CONTENTS AND DIFFERENT IONIC COMPOSITIONS. Kuznetsova, E. M. (Moscow State Univ.). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 10, 1462-4(Oct 1971).

Translated from Zh. Fiz. Khim.; 45: No. 10, 2584-7(Oct 1971).

A scheme, based on the concept of electrostatic interactions of ions (taking into account polarization) present in different amounts and with different percentage amounts of divinylbenzene in the cation-exchange resins, is proposed for calculation of ion-exchange equilibrium constants for singly charged cations. 54 exchange constants were calculated for the Na^+-LiR, K^+-NaR, and Cs^+-NaR systems on Dowex-50 resins. The calculated values agree satisfactorily with experimental literature data. (auth)

27843 CALCULATIONS FOR ION-EXCHANGE PROCESSES ON GLAUCONITES. Kolosova, G. M.; Nikashina, V. A.; Yakimova, M. N.; Serova, I. B.; Severinenko, E. Yu. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 10, 1466-9(Oct 1971).

Translated from Zh. Fiz. Khim.; 45: No. 10, 2592-2600(Oct 1971).

The constants for the exchange of potassium, cesium, calcium, and strontium for sodium on glauconites were determined. Glauconites exhibit the greatest sensitivity for the cesium ion (exchange constant >1000). The kinetic mechanism of the sorption of elements on a glauconite from dilute solutions (about 0.001 N) were investigated. External diffusion is shown to be the rate-determining stage. Strontium output curves were calculated under specified experimental conditions on the basis of the solution of the dynamic sorption equations in the external diffusion region. (auth)

27844 SYNERGIC EXTRACTION OF URANIUM WITH THEONYLTRIFLUOROACETONE AND TETRAPHENYLPHOSPHONIUM CHLORIDE. Katsura, Kosho (Ryukyu Univ., Japan); Shinagawa, Mutsuaki. Nippon Genshiryoku Gakkaishi; 14: No. 3, 100-5(Mar 1972). (In Japanese).

Uranium was synergically extracted with theonyltrifluoroacetone (TTA) and tetraphenylphosphonium chloride (TPPC). Maximum synergism was observed at pH 6.5 with 5×10^{-3}M TTA and 2×10^{-3}M TPPC. The relation between log D and log [L] revealed that the ratio of uranyl, TTA, and TPPC was 1:4:2. Uranyl tribenzoate, formed in benzoate–benzoic acid media, was also synergically extracted with TTA and TPPC. Maximum synergism was observed at pH 3 with 5×10^{-3}M TTA, 2×10^{-3}M TPPC, and 5×10^{-3}M sodium benzoate (NaB). The plot of log D and log [L] showed the ratio of uranyl, benzoate, TTA, and TPPC to be 1:3:2:3. (auth)

27845 APPLICABILITY OF KINETIC EQUATIONS FOR IDEALISED PROCESSES TO REAL ION-EXCHANGE SYSTEMS. Legenchenko, I. A.; Khromova, N. P.; Rakhubenko, T. G. (Inst. of General and Inorganic Chemistry, Odessa). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 10, 1472-4(Oct 1971).

Translated from Zh. Fiz. Khim.; 45: No. 10, 2604-8(Oct 1971).

It is suggested that the factors causing real systems to depart from ideal conditions can mutually cancel out, as a result of which the kinetics of real systems may be described by equations that are rigorously applicable only under ideal conditions. The applicability of such equations to experimental data obtained on lanthanum complexes was demonstrated. (auth)

27846 EXTRACTION OF ZIRCONIUM THIOCYANATE FROM SULFATE SOLUTIONS BY TRIBUTYL PHOSPHATE. Sinegribova, O. A.; Yagodin, G. A. Zh. Neorg. Khim.; 16: No. 10, 2760-5(Oct 1971). (In Russian).

The extraction of zirconium originally present as the sulfate or oxychloride in 0.5 N H_2SO_4 (which contained 100 g/l of NH_4SCN) by TBP diluted in benzene was studied. The extraction efficiency was studied in relation to: Zr concentration, phase volume ratio, and the concentrations of, respectively, extractant, NH_4SCN, and H_2SO_4. Acidities lower than 2 N H_2SO_4 resulted in considerable unextracted zirconium. (K.S.W.)

27847 USE OF ELECTRODIALYSIS FOR ISOLATION OF RARE ALKALI METALS FROM FLUORIDE SINTERS. Mikhailov, M. A.; Presnyakova, O. E.; Avrutskaya, G. Ya. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 9, 1994-7(Sep 1971).

Translated from Zh. Prikl. Khim.; 44: No. 9, 1962-5(Sep 1971).

Electrodialysis with ion-exchange membranes at current densities of 8, 17, and 20 mA/cm^2 and 50 to 100 V was used for decomposition of the product formed by fluorination of a micaceous material and separation of all the alkali metals from multivalent metals. Separation of the catholyte from the middle compartment by an anion-exchange membrane completely prevents penetration of multivalent ions into the cathode compartment. Preliminary separation of rare alkali elements can be achieved by passage of different quantities of electricity. (auth)

27848 VERSATILE SOLVENT SYSTEM FOR THE PAPER CHROMATOGRAPHY OF INORGANIC CATIONS. Poonia, N. S.; Bhagwat, Vasant; Singh, H. Sarwan (Vikram Univ., Ujjain, India). Mikrochim. Acta; No. 1, 36-41(1972).

The paper chromatographic resolution potential of the solvent system chloroform–acetone–isoamyl alcohol–11N HCl (1:1:1:0.5 v/v) for 48 cations was tested. Included are Ru(III), Te(IV) and (VI), Mo(VI), U(VI), Zr(IV), Th(IV), Ce(IV), Sc(III), Sr, and Y. Successful results with various multiconstituent mixtures are presented and R_f values of the common metal ions are tabulated. (auth)

27849 REACTION OF NEODYMIUM WITH SOLUTIONS OF DI-2-ETHYLHEXYLPHOSPHORIC ACID. Erin, E. A.; Krutikov, P. G.; Pushkov, A. A. (Moscow Chemical Tech. Inst.). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 14: No. 8, 1284-5 (1971). (In Russian).

Infrared spectra are illustrated for Amsco–di-2-ethylhexylphosphoric acid solutions resulting from the extraction of neodymium solutions. An absorption band at 1,200 cm^{-1} is attributed to the P = 0 valence vibration. A symmetrical P = 0 vibration, an OH group deformation, and other functional groups as represented by absorption bands are discussed. The effect of the presence of Nd is analyzed. (K.S.W.)

27850 TWO-STAGE COUNTERCURRENT LEACHING PROCESS FOR THE RECOVERY OF PHOSPHATES, YTTRIUM, AND RARE EARTH VALUES. Coltrinari, Enzo L.; Kindig, James K.

(to Molybdenum Corp. of America). U. S. Patent 3,647,361. 7 Mar 1972. Filed 3 Dec 1969.

Phosphates and yttrium and rare earth metal values are recovered from solid materials, particularly phosphate ores or commercial concentrates and especially apatites, in a two-stage leaching process comprising a first extraction with an aqueous acid solution to remove part of the phosphate and a substantial part of the yttrium and a second extraction with stronger acid to remove the residual phosphate, yttrium, and rare earth values, then recovering the products from the first and second extracts. The process is carried out in a countercurrent manner by using the aqueous acid solution from the second extraction, after partial removal of yttrium and rare earth values, in the first extraction. (Official Gazette)

27851 HIGH-SPEED SEPARATION OF THE RARE EARTHS BY ION EXCHANGE. PART II. Sisson, D. H. (Univ. of California, Livermore); Mode, V. Alan; Campbell, David O. J. Chromatogr.; 66: No. 1, 129-35(22 Mar 1972).

Using the techniques of high-pressure liquid chromatography, it was possible to separate mass quantities of all fourteen rare earths in less than 5 hr. The importance of solvent gradient, particle size, and resin crosslinkage were examined. (auth)

27852 CATION EXCHANGER ADSORPTION OF METAL IONS FROM DIETHYLENETRIAMINE-N,N,N',N'',N''-PENTAACETIC ACID. Zukriegelova, M.; Sixta, V.; Sulcek, Z. (Geologisches Zentralinstitut, Prague). Collect. Czech. Chem. Commun.; 37: No. 1, 68-79(Jan 1972). (In German).

The behavior of Cu^{2+}, Mg^{2+}, Ca^{2+}, Sr^{2+}, Zn^{2+}, Cd^{2+}, In^{3+}, Tl^{+}, Rb^{2+}, Th^{4+}, UO_2^{2+}, Mn^{2+}, Fe^{3+}, Co^{2+}, and Ni^{2+} in DTPA on strongly acidic cation exchangers was investigated in relation to the H^+ ion concentration. The distribution coefficients were compared with theoretical values. (tr-auth)

27853 FORMATION STUDY OF URANIUM COMPOUNDS AND OF SOME ACCOMPANYING ELEMENTS IN CH_2Cl–COOH MEDIUM BY PAPER ELECTROPHORESIS. I. SEPARATION OF UO_2^{2+} FROM Ce^{3+}, Fe^{3+}, Co^{2+}, Ni^{2+}, AND Cu^{2+}. Marcu, Gh.; Botar, A. Stud. Univ. Babes-Bolyai, Ser. Chem.; 16: No. 2, 109-15(1971). (In Rumanian).

The formation of UO_2^{2+}, Ce^{3+}, Fe^{2+}, Co^{2+}, Ni^{2+}, and Cu^{2+} complexes with CH_2Cl–COOH was studied by paper electrophoresis. It was established that in 0.3 M CH_2Cl–COOH medium only the UO_2^{2+} ion forms ionic species of the $UO_2(CH_2Cl-COO)^+$, $UO_2(CH_2Cl-COO)_2^0$, and $UO_2(CH_2Cl-COO)_3^-$ type. The other ions studied formed only ionic species of the $[Me_m(CH_2Cl-COO)_n]^{(m-n)+}$ type. The electrophoretic mobilities of these ionic species were calculated on Whatman paper Nr.1 at about 1100 V and 12 mA difference of potential, for 30 minutes. It was established that in 0.3 M CH_2Cl–COOH medium the uranium separates very well from Ce, Co, Ni, and Cu at pH = 2.40 to 3.70. Uranium separation from iron is achieved with difficulty as a part of iron migrates together with uranium. (auth)

27854 SEPARATION AND ENRICHMENT METHODS FOR MEASURING RADIOACTIVITY IN THE ENVIRONMENT. Minczewski, J. (Technical Univ., Warsaw). pp 57-69 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

A brief description is given of the role of separation and enrichment methods in determining traces of radionuclides in environmental samples. The secondary contamination and losses of the sample are then discussed, and the differences between the behavior of traces of radionuclides and traces of stable isotopes are shown. This is followed by a brief description of the main separation and enrichment methods: precipitation and coprecipitation, chromatography, liquid–liquid extraction, volatilization, and other methods. Each method is described, and its utility for determining traces of radionuclides in environmental samples is discussed. Some examples of methods used routinely are added. In conclusion, there are general remarks concerning the role of masking agents in the separation process. (auth)

27855 COBALT SULFIDES, AN EFFECTIVE COLLECTOR FOR RADIORUTHENIUM COMPLEXES IN SEAWATER. Yamagata, N.; Iwashima, K. (Inst. of Public Health, Tokyo). pp 85-90 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

Collection of radioruthenium in different chemical states in seawater was studied for the purpose of monitoring. About 0.5 to 1.0 mg of cobalt(II) carrier was added to 100 ml of seawater, followed by the addition of ammonium hydroxide and thioacetamide. Cobalt sulfide was precipitated homogeneously at a pH range of 9.0 to 9.5 by heating the mixture for about 1 h at 90 to 95°C. All the ruthenium chloro-, nitrosylruthenium chloro-, and nitrosylruthenium nitro-complexes were effectively recovered. The precipitate of cobalt sulfide is easily filterable and served for gamma spectrometric determination. (auth)

27856 RAPID RADIOCHEMICAL SEPARATIONS. Herrmann, G. (Univ., Mainz). pp 133-49 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

As a result of studies on short-lived nuclei of new isotopes of known elements, rapid radiochemical separations are being developed permitting, within a few seconds, the isolation of individual elements from complex mixtures. Such techniques and procedures may also be applicable, after appropriate modifications, to measurements of radioactivity in the environment. Pertinent techniques, particularly separations from aqueous solutions, are reviewed. It is shown how typical separation steps can be made more rapidly. The combination and application of such techniques is demonstrated by the isolation of short-lived isotopes of zirconium by solvent extraction and of arsenic by volatilization. Other procedures are briefly summarized, and some examples of different approaches to rapid radiochemical separations are given. (auth)

27857 SEPARATION OF CADMIUM(II) FROM ZINC(II) AND OTHER METAL IONS ON A CADMIUM SELECTIVE EXCHANGER: TITANIUM SELENITE. Qureshi, Mohsin; Kumar, Rajendra; Rathore, H. S. (Aligarh Muslim Univ., India). Anal. Chem.; 44: No. 6, 1081-4(May 1972).

A simple and rapid method for the highly selective separation of cadmium from numerous metal ions using a titanium selenite column is described. Distribution coefficients of metal ions on titanium selenite at 25 ± 1°C are tabulated. Included among these ions are Zn^{2+}, Sr^{2+}, Hg^{2+}, Ce^{3+}, Y^{3+}, La^{3+}, Sc^{3+}, Pr^{3+}, Nd^{3+}, Sm^{3+}, UO_2^{2+}, Th^{4+}, ZrO^{2+}, and HfO^{2+}. (J.G.B.)

27858 SOLVENT EXTRACTION OF URANIUM FROM SCANDIUM, YTTRIUM, OR HAFNIUM. Agarwala, B. V.; Dey, A. K. (Univ. of Allahabad, India). Indian J. Appl. Chem.; 31: No. 5-6, 189-91(1968). NSA

A solvent extraction method is described for the separation of U^{6+} from Sc^{3+}, Y^{3+}, or Hf^{4+}, using sodium diethyldithiocarbamate as a complexing agent and n-butanol or ethyl methyl ketone for the extraction of the U complex. It was found that 2.39 to 9.56 mg of U can be extracted from a binary mixture containing 2.25 to 9.0 mg of Sc, 4.45 to 17.70 mg of Y, and 8.93 to 35.72 mg of Hf. U was determined spectrophotometrically. The pH in the alcoholic extract between which the separation can be carried out successfully is 2.0 and 3.5. The following cations interfere: Cu^{2+}, Fe^{3+}, Co^{2+}, Bi^{3+}, Ni^{2+}, Cr^{6+}, Te^{4+}, Se^{4+}, Ag^{+}, Hg^{2+}, As^{3+}, Sn^{4+}, Cd^{2+}, Mo^{6+}, W^{6+}, Mn^{2+}, V^{5+}, Zn^{2+}, In^{3+}, Tl^{+}, Os^{3+}, and Nb^{5+}. (Ind. Sci. Abstr.)

27859 EXTRACTION OF TRANSPLUTONIUM ELEMENTS WITH TRI-n-OCTYLAMINE. Milyukova, M. S.; Myasoedov, B. F.; Ryzhova, L. V. Zh. Anal. Khim.; 27: No. 1, 67-72(Jan 1972). (In Russian).

The extraction of trivalent transplutonium elements and europium with trioctylamine solutions in various organic solvents from aqueous nitric acid solutions was studied. The effect of the concentrations of nitric acid, nitrate ions, and trioctylamine on the extraction of transplutonium elements and europium was examined. Transplutonium elements and europium are quantitatively extracted with a 0.44 M solution of trioctylamine in cyclohexane from 0.1 to 0.2 M HNO_3 solutions containing 7.2 M $LiNO_3$. (auth)

27860 SORPTION OF NEPTUNIUM ON ANION EXCHANGERS FROM ALKALINE SOLUTIONS. Novikov, Yu. P.; Myasoedov, B. F.; Ivanova, S. A. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 27: No. 1, 63-6(Jan 1972). (In Russian).

Sorption of neptunium from alkaline solutions of neptunium(VII) on anion exchangers AV-17, Amberlite IRA-400, and Dowex-1 was studied in relation to alkali concentration, time, and the content of divinylbenzene. Optimum conditions for neptunium sorption were found and the sorbent capacity was determined as 3.8×10^{-2} mg · atom/g for AV-17 and 5.9×10^{-2} mg · atom/g for Dowex-1 × 4.

The mechanism of neptunium sorption on anion exchangers was elucidated by comparing with sorption on KU-2 cation exchanger, active charcoal, and titanium dioxide. The irreversible nature of sorption was established for all the sorbents due to the reduction of neptunium(VII). (auth)

27861 EXTRACTION OF FLUOROTANTALATE ANION WITH BASIC DYES. Tarayan, V. M.; Ovsepyan, E. N.; Barkhudaryan, S. R. (Erevan State Univ.). Zh. Anal. Khim.; 27: No. 1, 19-24(Jan 1972). (In Russian).

The effect of oxalate ions on the formation and extraction into the organic phase of compounds of fluorotantalate anions with cations of basic dyes (Methyl Green, Methylene Blue, and Acridine Orange) was studied. The reaction ability of tantalum is higher on the treatment of the tantalum-containing solution with fluoride instead of oxalate. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 30101, 30105, and 30124.

Chemical and Physical-Chemical Properties

Refer also to abstracts 27935, 27937–27939, 27951, 27961, 27977, 28608, 28610, and 28624.

27862 (ANL-7878) CHEMICAL ENGINEERING DIVISION, PHYSICAL INORGANIC CHEMISTRY SEMIANNUAL REPORT, JULY-DECEMBER 1971. Blander, M.; Cunningham, P. T.; Eberhart, J. G.; Feder, H. M.; Maroni, V. A.; Schnyders, H. C.; Veleckis, E.; Tevebaugh, A. D.; Vogel, R. C. (Argonne National Lab., Ill.). Mar 1972. Contract W-31-109-eng-38. 29p. Dep. NTIS.

Work is reported covering several diverse areas of physical and inorganic chemistry. The limit of superheat for several organic compounds was measured with vaporization temperatures ranging from 104 to 139 degrees above the boiling point. These data, together with other data from the literature, were used to develop an empirical correlation interrelating the vaporization temperature, the critical temperature, and the normal boiling point. Existing thermodynamic data on the lithium–hydrogen system were correlated and predictions made relating to tritium permeation rates in the core of a D–T fusion reactor. The conductivity of lithium selenide (a possible solid electrolyte for an electrochemical cell) as a function of temperature and various additives is reported. Raman spectroscopy was used to study the behavior of the iodate ion in molten nitrates. (auth)

27863 (BNL-50011) SOLID-STATE REACTION OF LITHIUM HYDRIDE AND ALUMINUM. Aronson, S.; Salzano, F. J. (Brookhaven National Lab., Upton, N. Y.). Jun 1965. Contract [AT(30-2)-Gen-16]. 12p. Dep. NTIS.

Declassified 27 Oct 1971.

Lithium hydride reacts reversibly with aluminum at 450 to 550°C to form LiAl and hydrogen. The vapor pressure of hydrogen in the system was measured as a function of temperature. Thermodynamic information on the Li–Al–H system and on the Li–Al system was obtained. (auth)

27864 (SGAE-M-37/1971) RETAINING CAPACITY OF A MANY-LAYERED MEMBRANE. Degischer, H. P.; Kleinert, W. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Institut fuer Metallurgie). [1971]. 28p. (In German). Dep. NTIS (U. S. Sales Only).

A theoretical treatment of particle flow through a multilayer membrane, of interest in containment of radioactive materials, is presented. The transport problem was handled according to the principle of equalization of the chemical potential and the concentration ratio was determined by a difference method with the help of an analog calculator. (M.C.G.)

27865 POLAROGRAPHIC BEHAVIOR OF PLUTONIUM. Motojima, Kenji; Kihara, Sorin; Yamamoto, Tadashi (Japan Atomic Energy Research Inst., Tokai). Polarographii; 17: No. 4, 101-8(Sep 1971).

Polarographic behavior of the $Pu^{4+} \rightleftharpoons Pu^{3+}$ system was studied in various mineral and organic acids. The standard oxidation and reduction potential of this system is +0.97 V vs NHE, therefore solid electrodes, such as platinum, were used except in solvents which have strong tendency to produce complexes. In aqueous solutions Pu^{3+} is easily oxidized by dissolved oxygen. Reproducible oxidation and reduction waves were obtained by the use of solutions of the chloride, nitrate, sulfate, perchlorate, citrate, and oxalate of Pu^{4+} and Pu^{3+} ions. The preparation of these solutions is described. Half-wave and peak potentials of plutonium are tabulated for various acid solution. Effects of acid concentration on the half-wave potential are also given for HCl, HNO_3, H_2SO_4, and $HClO_4$ for Pu concentrations between 0.2 and 10.0N for both reduction and oxidation. (FUKUTOMI, T.) (Japan)

27866 PHOTOCHEMICAL REACTIONS IN ANALYTICAL CHEMISTRY. COMMUNICATION 11. THE CHANGE OF VARIOUS VALENCE STATES OF NEPTUNIUM IN PERCHLORIC ACID SOLUTIONS ON THEIR IRRADIATION WITH ULTRAVIOLET LIGHT. Nemodruk, A. A.; Bezrogova, E. V.; Ivanova, S. A.; Novikov, Yu. P. Zh. Anal. Khim.; 27: No. 1, 73-7(Jan 1972). (In Russian).

The effect of irradiating neptunium solutions in perchloric acid with light from a PRK-7 mercury-quartz lamp was studied depending on the starting valence state of neptunium, the concentrations of perchloric acid and neptunium, the irradiation time, and a number of other factors. On irradiation; neptunium(IV) is completely oxidized to neptunium(V), which is then oxidized to neptunium(VI), but the oxidation to neptunium(VI) does not proceed completely as an equilibrium between neptunium(VI) and neptunium(V) is settled. An increase of the $HClO_4$ concentration increases the yield of neptunium(VI) (up to 96% in 4.8 M $HClO_4$). On irradiation in the presence of ethanol, neptunium(VI) and neptunium(V) are rapidly and completely reduced to neptunium(IV); on irradiation in the presence of hydrogen peroxide, only neptunium(V) is formed. (auth)

27867 NEW ELECTROCHEMICAL MEASUREMENTS OF THE LIQUIDUS IN THE LiF–BeF_2 SYSTEM. CONGRUENCY OF Li_2BeF_4. Romberger, K. A.; Braunstein, J.; Thoma, R. E. (Oak Ridge National Lab., Tenn.). J. Phys. Chem.; 76: No. 8, 1154-9(13 Apr 1972).

Emf measurements of cells with transference provide a method for precise determinations of the liquidus in binary salt systems if the emf is stable, reproducible, and responsive to the change of activity of a component in the melt accompanying a phase change in one of the half cells. The method is described as applied to new measurements of the liquidus of the system LiF–BeF_2 at compositions between 0.12 and 0.58 mole fraction BeF_2 with a precision of about ±0.0002 mole fraction BeF_2 and ±0.2°. The direction of the emf change at the onset of precipitation provides virtually unequivocal distinction between a peritectic, eutectic, or congruent melting point. Our measurements indicate congruency of Li_2BeF_4 with a melting point of 459.1°. The maximum in the liquidus lies close to the eutectic of Li_2BeF_4–LiF, hence it is difficult to establish by conventional means. The LiF–Li_2BeF_4 eutectic occurs at 0.3280 mole fraction BeF_2 and 458.9°. (auth)

Isotope Effects

27868 (COO-1008-22) FINAL ANNUAL TECHNICAL PROGRESS REPORT. (Indiana Univ., Bloomington). Mar 1972. Contract AT(11-1)-1008. 6p. Dep. NTIS.

Research on secondary deuterium isotope effects is summarized. Topics covered include: sulfonate leaving groups, solvolysis of neopentyl sulfonates, solvolysis and d-rate effects for trifluoroethanesulfonates, automation of collecting of reaction rate data, and improvement of precision of rates measured spectrophotometrically. (M.C.G.)

27869 (UR-3999-13) VAPOR PRESSURES OF ISOTOPIC KRYPTON MIXTURES. INTERMOLECULAR FORCES IN SOLID AND LIQUID KRYPTON. Lee, Myung W.; Eshelman, Donald M.; Bigeleisen, Jacob [Rochester Univ., N. Y. Dept. of Chemistry]. [nd]. Contract AT(30-1)-3999. 40p. Dep. NTIS.

The vapor pressures of normal krypton and a krypton sample containing 50 percent ^{80}Kr were measured from 94 to 130°K. New vapor pressure equations were derived for solid and liquid normal krypton. The triple point pressures and (temperatures) of ^{80}Kr and ^{84}Kr are 547.56_5 (115.77) and 547.50_2 (115.78) int. mm. Hg (°K), respectively. The triple point pressure of normal krypton is 547.52 ± 0.10 int. mm. Hg. The reduced partition functions, fc/fg, of $^{84}Kr/^{80}Kr$ were derived for the solid and liquid from the vapor pressure data. The solid data lead to a Θ_0 (Debye) = 71.8°K in excellent agreement with heat capacity data. The change in ln (fc/fg) on melting was found to be 24%, in good agreement with previous results on neon and argon. $V\langle\nabla^2\rangle$ was derived from the experimental values of ln (fc/fg) in the liquid. The repulsive potential in liquid krypton was less steep than that in neon or argon. Calculations of $V\langle\nabla^2 U\rangle$ from neutron scattering measurements showed the exp-6 potential to be superior to the L–J (12,6) potential for liquid krypton. A corresponding states analysis through $\langle\nabla^2 U^*\rangle$ led to a quantitative correlation of the solid and liquid phase (fc/fg) data for Ne, Ar, and Kr. (auth)

27870 MICROWAVE SPECTRUM, STRUCTURE, AND DIPOLE MOMENT OF BICYCLO[2.1.0]PENTANE. Suenram, Richard D.; Harmony, Marlin D. (Univ. of Kansas, Lawrence). J. Chem. Phys.; 56: No. 8, 3837-42(15 Apr 1972).

The microwave spectra of the normal and three singly substituted ^{13}C isotopic species of bicyclo[2.1.0]pentane were assigned and analyzed. Using the moments of inertia derived from these spectra the following structural parameters were obtained for the carbon skeleton: $C_1-C_2 = C_3-C_4 = 1.528$ Å, $C_2-C_3 = 1.565$ Å, $C_1-C_4 = 1.536$ Å, $C_1-C_5 = C_4-C_5 = 1.507$ Å, and the dihedral angle $\alpha = 67.26°$. The disagreement of these results with those of an earlier electron diffraction study is discussed. A reanalysis of the electron diffraction data may lead to concurrence with the results of the present study. Structural parameters were compared to those of other cyclic systems and the essential constancy of the average C–C distances in cyclobutyl systems and also in cyclopropyl systems is discussed. Stark effect measurements yielded a total dipole moment of 0.27 D. (auth)

27871 INFRARED ABSORPTIONS OF INTERSTITIAL HYDROGEN ATOMS IN SOLID ARGON AND KRYPTON. Bondybey, Vladimir E.; Pimentel, George C. (Univ. of California, Berkeley). J. Chem. Phys.; 56: No. 8, 3832-6(15 Apr 1972).

Infrared absorptions are reported in the spectra of inert gas–hydrogen matrix samples deposited after the gas mixture passed through a glow discharge. For hydrogen in argon, absorption is recorded at 905 cm^{-1}. This band shifts to 644 cm^{-1} for deuterium in argon and no new bands are observed with hydrogen–deuterium mixtures. With krypton matrix, similar absorptions are observed at 852 cm^{-1} (H_2–Kr) and at 607 cm^{-1} (D_2–Kr). Prolonged infrared irradiation in the spectral range of the absorptions causes them to disappear, the hydrogen absorptions more rapidly than the deuterium features. No similar bands could be detected when xenon or neon matrixes were used. The very small $^{36}Ar-^{40}Ar$ isotopic shift (0.2 ± 0.1 cm^{-1}) shows that the argon absorptions cannot be attributed to HAr, to HAr^+ or to HAr_2^+. The evidence is consistent with the interpretation that both in argon and in krypton, the absorptions are due to hydrogen atoms trapped in O_h interstitial sites in an undistorted inert gas lattice. This interpretation is supported by ab initio calculations for H atoms in a neon lattice. The loss on infrared irradiation is attributed to intramolecular energy transfer into local lattice vibrational motion, which permits escape from the interstitial site and recombination. (auth)

27872 EXTENT OF BOND FORMATION IN THE TRANSITION STATE FOR ALKYLATION AT NITROGEN AND AT CARBON. Bare, Thomas M.; Hershey, N. Davis; House, Herbert O.; Swain, C. Gardner (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-905. J. Org. Chem.; 37: No. 7, 997-1002(7 Apr 1972).

Chlorine isotope effects (k_{35}/k_{37}) in reactions of methyl chloride with 4-tert-butyl-1-ethylpiperidine, triethylamine, and the lithium salt of 4-tert-butylcyclohexanecarbonitrile in 1,2-dimethoxyethane solution at 25°C are identical (1.0064) within experimental precision (0.0001) but considerably smaller than with sodium iodide (1.0086), indicating an "early" transition state for the amines and the enolate, with nearly the same small degree of bond formation at their transition states. Stereochemical differences between piperidines and enolates are therefore interpreted by consideration of relative steric strain in transition states for axial vs equatorial alkylation, at relatively long but similar N–C and C–C distances. (auth)

27873 ISOTOPE EFFECT IN THE SORPTION OF CARBON DIOXIDE BY SYNTHETIC ZEOLITES. Loseva, T. I.; Kochurikhin, V. E.; Zel'venskii, Ya. D. (Moscow Inst. of Chemical Engineering). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 9, 1313-14(Sep 1971).

Translated from Zh. Fiz. Khim.; 45: No. 9, 2328(Sep 1971).

The isotope separation factors for carbon and oxygen in the sorption of carbon dioxide by various synthetic zeolites were measured. (auth)

27874 ISOTOPE EFFECT IN THE SOLUBILITY OF HYDROGEN IN FCC METALS. Vykhodets, V. B.; Geld, P. V.; Demin, V. B.; (and others) (Inst. of Metallurgy, Sverdlovsk, USSR. Ural Polytechnical Inst., Sverdlovsk, USSR). Phys. Status Solidi (a); 9: No. 1, 289-300(16 Jan 1972).

A method for calculating the isotope effect in the solubility of hydrogen isotopes in fcc metals is proposed. Compared with previous calculations, where only local vibrations of interstitial atoms were considered, the change in density of states of solution in the continuous spectrum band is discussed. Elastic vibration spectrum analysis of the crystal with an impurity atom in internode was performed in harmonic approximation, utilizing the model of equal central and non-central interactions between atoms. It was found that the contribution of the change of a continuous spectrum band to the value of solubility (and isotope effect) was rather small and increased with the increase of temperature and the decrease of principal matrix atom mass. (auth)

27875 HETEROGENEOUS EXCHANGE OF NITROGEN ISOTOPES IN NITRIDES. Ivanova, T. F.; Fedorov, V. V. Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 10, 1471-2(Oct 1971).

Translated from Zh. Fiz. Khim.; 45: No. 10, 2601-3(Oct 1971).

Chromium, niobium, and zirconium nitrides, which are thermally stable, exchange nitrogen isotopes at comparatively low temperatures when the degree of their dissociation is low. (auth)

27876 ISOTOPE EFFECTS IN THE VELOCITY OF SOUND IN MIXTURES OF DEUTERIUM PEROXIDE AND HEAVY WATER AND THEIR ADIABATIC COMPRESSIBILITY. Tsvetkov, V. G.; Rabinovich, I. B. (Gorky State Univ., USSR). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 11, 1550-1(Nov 1971).

Translated from Zh. Fiz. Khim.; 45: No. 11, 2731-3(Nov 1971).

The velocity of sound, u, in mixtures of deuterium peroxide with heavy water and of hydrogen peroxide with ordinary water was investigated and the adiabatic compressibilities of the mixtures β_{ad} were calculated. The isotope effects in u and β_{ad} and also in certain other properties of D_2O_2 were compared with the isotope effects in the properties of D_2O. (auth)

27877 INFRARED MATRIX AND THEORETICAL STUDIES OF THE REDUCTION OF MOLECULAR NITROGEN BY LITHIUM ATOMS. Spiker, Robert C. Jr.; Andrews, Lester; Trindle, Carl (Univ. of Virginia, Charlottesville). J. Amer. Chem. Soc.; 94: No. 7, 2401-6(5 Apr 1972).

The 15°K matrix codeposition of lithium atoms and nitrogen molecules produces new absorptions at 1800 and 1535 cm^{-1}, which exhibit small lithium isotopic shifts and ^{15}N shifts appropriate for N–N fundamental vibrations. The use of nitrogen isotopic mixtures indicates that the 1535-cm^{-1} feature is due to a species containing two equivalent N_2 units, each with inequivalent nitrogen atoms. Concentration studies suggest the assignments to the molecules LiN_2 and $N_2Li_2N_2$. Molecular orbital calculations suggest that the Li–N_2 union requires a surface reaction and that the most likely source of $N_2Li_2N_2$ is dimerization of LiN_2 formed in adjacent matrix sites. (auth)

27878 STUDY OF THE SOLUBILITY OF NON-POLAR AMINO ACIDS IN LIGHT AND HEAVY WATER IN CONNECTION WITH THERMAL STABILITY OF PROTEINS. Klimov, A. I.; Deshcherevskii, V. I. (Moscow State Univ.). Biophysics (USSR) (Engl. Transl.); 16: No. 3, 580-4(1971).

Translated from Biofizika; 16: No. 3, 556-9(1971).

The solubility of nonpolar amino acids of the aliphatic series was studied in light and heavy water. With an accuracy to ±5 cal/mole, the standard free energies, $\delta\Delta F$, of the transfer of nonpolar side radicals of amino acids from H_2O to D_2O were determined. It was shown that the main contribution of $\delta\Delta F$ was due to the first CH_2-group of the aliphatic chain ("effect of screening of the polar interactions"). Contribution to $\delta\Delta F$ of the remote links of the aliphatic chain (change in the hydrophobic interactions) at 12° was negative, at 25° was approximately equal to zero, and at 47° did not exceed +10 cal/mole of CH_2-groups (such intensification of the hydrophobic interaction was insufficient to explain the increase in the thermal stability of protein in D_2O). (auth)

Isotope Exchange and Isotope Separation

Refer also to abstract 28557.

27879 (UR-3999-12) LIQUID-VAPOR ARGON ISOTOPE FRACTIONATION FROM THE TRIPLE POINT TO THE CRITICAL POINT. MEAN LAPLACIAN IN LIQUID ARGON. Phillips, James T.; Linderstrom-Lang, Carl U.; Bigeleisen, Jacob (Rochester Univ., N. Y. Dept. of Chemistry). [1971]. Contract AT(30-1)-3999. 43p. Dep. NTIS.

The statistical thermodynamic treatment of equilibrium between a non-ideal liquid mixture of isotopes and a vapor phase was extended to include isotope effects on the equation of state of the gas. The result is particularly simple when the isotopic partition functions in a given phase are compared at the same molar volume. The isotope fractionation factor, α, for $^{36}Ar/^{40}Ar$ between liquid and vapor was measured from the triple point to the critical temperature. The results are compared with previous vapor pressure data, which cover the range 84 to 102°K. Although the agreement is within twice the statistical scatter of the present data, the present results for $\ln\alpha$ are systematically 5% lower than calculations from vapor pressure data. It is shown

that $^2T \ln\alpha$ is a linear function of $(\rho_c - \rho_g)$, the density difference between the liquid and vapor, in the range 84 to 120°K. The fractionation factor approaches zero at the critical temperature with a nonclassical critical index equal to 0.42 ± 0.02. $\langle\nabla^2 U_c\rangle/\rho_c$ in liquid argon was derived from the experimental fractionation data and calculations of $\langle\nabla^2 U_g\rangle/\rho_g$ for a number of potential functions for gaseous argon. (auth)

27880 H–D ISOTOPIC EXCHANGE IN ACTIVE METHYL AND METHYLENE COMPOUNDS. I. Bologa, Margareta (Inst. of Stable Isotopes, Cluj). Stud. Cercet. Chim.; 19: No. 10, 1069-92(Oct 1971). (In Rumanian).

H–D isotopic exchange reactions, including redistribution of H and D between two materials or between reactants and products of a chemical reaction, in active methyl and methylene groups, are reviewed, covering the period up to the end of 1969. The hydrogen atoms of the C–H bonds in methyl and methylene groups participate in exchange reactions with deuterium donors under a variety of conditions: alkaline, acid, and amphoteric media and presence and absence of acid-base catalysts. The mechanism involved in the reaction is similar to that encountered in substitution reactions. Experimental techniques used are also critically reviewed. Among the factors considered was the effect of the formation of carbonium ions on the reaction with deuterated compounds. (Review article, 42 references). (TTT)

27881 H–D ISOTOPIC EXCHANGE IN ACTIVE METHYL AND METHYLENE GROUPS IN HETEROCYCLIC COMPOUNDS. II. Bologa, Margareta; Gard, Eugenia (Inst. of Stable Isotopes, Cluj. Inst. of Atomic Physics, Bucharest). Stud. Cercet. Chim.; 19: No. 12, 1329-51(Dec 1971). (In Rumanian).

Publications on the H–D isotopic exchange reaction in active methyl and methylene groups contained in heterocyclic compounds are reviewed. Papers up to the end of 1970 are considered. The hydrogen atoms in the C–H bonds interact with deuterium donors, following a mechanism similar to that of the substitution of hydrogen. The isotopic technique yields information concerning the reactivity of the H atoms in the respective compounds as a function of the structure of the compound and the characteristics of the reaction medium. Mono and polyheteroatomic heterocyclic compounds with 5- and 6-atom rings, containing N, O, and S as the hetero atom were examined. (Review article, 35 references) (TTT)

27882 ISOTOPE SEPARATION DURING EXCHANGE BETWEEN MOLECULES IN THE GAS PHASE AND IONS IN A SOLID ION-EXCHANGE RESIN. III. DETERMINATION OF HETP BY EXCHANGE BETWEEN AMMONIA AND THE AMMONIUM FORM OF THE RESIN IN A COUNTERCURRENT COLUMN. Bairamov, V. T.; Safonov, M. S.; Gorshkov, V. I. (Moscow State Univ.). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 11, 1645-7(Nov 1971).

Translated from Zh. Fiz. Khim.; 45: No. 11, 2909-10(Nov 1971).

The HETP during exchange on a dry KU-2 × 9 cation exchange resin was measured experimentally in a countercurrent column. Calculations were made both from the initial slope of the kinetic curve and from the stationary distribution. (auth)

27883 STUDYING ISOTOPIC EXCHANGE OF OXYGEN IN CO_2–H_2O SYSTEM ON A PACKED COLUMN. Andreev, B. M.; Gumenyuk, T. D.; Zel'venskii, Ya. D. (Moscow Physical-Technical Inst.). Tr. Mosk. Khim.-Tekhnol. Inst.; No. 67, 100-4(1970). (In Russian).

An experimental investigation of the kinetics of the oxygen exchange in the system CO_2–H_2O was conducted in a packaged column in the presence of a number of additives. The effect of loading, pressure, and temperature on the behavior of the column was also studied. (tr-auth)

27884 GAS CHROMATOGRAPHIC ANALYSIS OF COMPLEX DEUTERATED AND TRITIATED MIXTURES WITH PACKED COLUMNS. Bruner, Fabrizio; Ciccioli, Paolo; Di Corcia, Antonio (CNR, Rome. Univ., Rome). Anal. Chem.; 44: No. 6, 894-8(May 1972).

High efficiency packed columns of about 100 m in length and 130,000 theoretical plates were used to separate isotopic mixtures with tritium, as they are originated by the reaction between propene and HT in the presence of catalysts. Separations were carried out at easily controllable temperature, such as 0 and −78°C. Quantitative analysis can be made also for deuterated mixtures like C_2H_6–C_2H_5D and C_2H_1D–C_2H_6. (auth)

Feed Materials Processing

Refer also to abstracts 28044 and 28045.

27885 (DOCKET-408102-3) HIGHLAND URANIUM MILL. Statement Furnished to Continue Construction and to Obtain Exemption From Sections 40.31 (f) and 40.32 (e) of Title 10. (Humble Oil and Refining Co., Houston, Tex. Minerals Dept.). 10 Apr 1972. 2p. Dep. NTIS.

Radiation Chemistry

Refer also to abstracts 27926, 27970, 27981, 28329, 29175, 29982, 29983, and 30010.

27886 (FRNC-TH-139) MEASUREMENT OF THE MEAN ENERGY NECESSARY TO CREATE AN ION PAIR IN A α IRRADIATED LIQUID DIELECTRICS. IONIZATION INHIBITION IN THESE COMPOUNDS. Ramy, Jean-Pierre (Toulouse Univ. (France). Faculte des Sciences). 1971. 98p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The ionization produced by ^{210}Po α particles in liquid hydrocarbons was investigated. The average energy necessary to create ion pairs (using Jaffe theory) and the free ion yields per 100 eV of energy absorbed at zero field were determined. The intersection of the extrapolated experimental/I = f(E) plateau with the electric field axis is related to theoretical data (LET) for both α particle and γ radiations. The factors affecting the ionization inhibition due to ^{60}Co photons and ^{210}Po α particles were also studied for these hydrocarbons. The effects of both types of radiations were compared and the inhibition mechanism was studied. (auth)

27887 (ORNL-TM-3717) RADIOLYSIS AND HYDROLYSIS IN SALT-MINE-BRINES. Jenks, G. H. (Oak Ridge National Lab., Tenn.). Mar 1972. Contract W-7405-eng-26. 99p. Dep. NTIS.

A detailed review and analysis of literature information bearing on the radiation and thermal chemistries of salt and brines within the vicinity of a buried waste can in a salt-mine, high-level, waste repository are presented. The objectives were to identify the final radiolysis and thermal reaction products and to estimate the amounts formed and released into the spaces around a can. Important radiolysis products include H_2, O_2, possibly ClO_3^- and BrO_3^-. Most of the ClO_3^- and BrO_3^- will decompose to halides and O_2 at the high temperatures around a can; $Mg(BrO_3)_2$ if present may give rise to some Br_2. Nearly all of the H_2, and the accompanying oxidized species, are formed within the migrating brine inclusions by the radiations absorbed within the brine and by dissolution of the interstitial chlorine and trapped electrons from the irradiated solid salt. The brine is rich in $MgCl_2$ (2.3 to 3M), and hydrolysis of the $MgCl_2$ around a can will produce HCl. (auth)

27888 (RRL-3238-387) APPLICATION OF CHARGE SCAVENGING KINETICS TO THE FORMATION OF EXCITED STATES IN IRRADIATED SOLUTIONS OF AROMATICS IN CYCLOHEXANE. Rzad, Stefan J. (Mellon Inst., Pittsburgh, Pa. Radiation Research Labs.). 6 Mar 1972. Contract AT(11-1)-3238. 41p. (CONF-720408-2). Dep. NTIS.

From Conference on elementary processes in radiation chemistry; Notre Dame, Ind. (4 Apr 1972).

Charge scavenging kinetics established previously to account for the time dependence of the biphenylide ion in pulse-irradiated biphenyl–cyclohexane solutions were extended to the formation of excited states in such solutions. From comparison of the predicted behavior and the experimental data available from the literature it was concluded that the triplets and singlets originate in the three different recombination processes: $S^+ + e$, $S^- + RH^+$, and $S^- + S^+$. Moreover λ, the constant characterizing the ion recombination processes in the pure solvent, can be interpreted to be $\sim 2 \times 10^{11}$ sec^{-1}, which indicates that half of the original ions recombine in ~3 psec. This in turn indicates that the rate constant for electron scavenging by biphenyl in cyclohexane is $\sim 3 \times 10^{12}$ M^{-1} sec^{-1}. Implications of these constants are discussed. (auth)

27889 ELECTRON SPIN RESONANCE STUDY OF TRAPPED ELECTRON IN 2-METHYLTETRAHYDROFURAN IRRADIATED AT 4°K. Yoshida, Hiroshi (Hokkaido Univ., Sapporo); Ogasawara, Masaaki; Warashina, Tetsuo; Higashimura, Takenobu. J. Chem. Phys.; 56: No. 8, 4238-9(15 Apr 1972).

The dependence of the yield of trapped electrons and electron capture by the solute biphenyl on irradiation temperature was examined to help elucidate the electron trapping process in organic glasses. The relative yields of trapped electrons at 4 and 77°K were determined as $G(e_T^-)_{4K}/G(e_T^-)_{77K} = 0.75 \pm 0.04$. About 0.2 mole % of biphenyl was needed to scavenge all the trapped electrons at 77°K. (M.C.G.)

27890 RADIATION-CHEMICAL OXIDATION OF TRICHLOROETHYLENE. Poluektov, V. A.; Mekhryushev, Yu. Ya. (Phys-

icochemical Inst., Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 9, 1319-20(Sep 1971).

Translated from Zh. Fiz. Khim.; 45: No. 9, 2335-7(Sep 1971).

The liquid-phase oxidation of trichloroethylene was investigated in the range 30 to 70°C. The reaction was initiated by ^{60}Co γ radiation. The rate of reaction increased linearly with the concentration of trichloroethylene and was proportional to the square root of the rate of initiation of the initial reaction centers. The rate increased linearly with the concentration of oxygen at low values of the latter but ceased to vary when the concentration increased further. The effective activation energy was 8 kcal $mole^{-1}$. A mechanism is proposed for the elementary oxidation reactions of halogenoethylenes, which explains the composition of the reaction products and the kinetics. (auth)

27891 DESORPTION OF HYDROGEN CHLORIDE IN THE PROCESS FOR CHLORINATING PARAFFINIC HYDROCARBONS IN THE LIQUID PHASE. Kosorotov, V. I.; Dzhagatspanyan, R. V.; Stul, B. Ya. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 8, 1833-6(Aug 1971).

Translated from Zh. Prikl. Khim.; 44: No. 8, 1815-19(Aug 1971).

The solubility of HCl in tetradecane and of Cl_2 in tetradecane in the presence of HCl, the HCl content in a liquid hydrocarbon during radioinduced chlorination, and the rate of HCl desorption from a supersaturated solution were studied. The presence of HCl in the liquid phase during chlorination had no effect on the equilibrium concentration of chlorine in the hydrocarbon. During chlorination in the liquid phase an HCl concentration was set up, which exceeded the quilibrium value at the given temperature and a pressure of 1 atm. The stationary concentration of HCl in the hydrocarbon during chlorination increased to some limit with increasing reaction rate and decreased on stirring the reaction mixture. All the HCl formed during the reaction diffused into the gas phase in bubbles of chlorine. (M.C.G.)

27892 REACTIONS OF HYDROGEN ATOMS WITH SOLID ISOCYANATES AND ISOTHIOCYANATES. Trofimov, V. I.; Chkheidze, I. I. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 5, 363-8(Sep-Oct 1971).

Translated from Khim. Vys. Energ.; 5: No. 5, 404-10(Sep-Oct 1971).

Radicals formed by the reaction of atomic hydrogen with solid isocyanates and isothiocyanates and during their radiolysis in the solid phase were investigated by EPR. Saturated and aromatic compounds were studied. It turned out that the NCO and NCS groups are good hydrogen-atom acceptors and are capable of competing with the phenyl ring and the nitro group in their capture. The direction of the reaction (addition to the C = C and N = O bonds or N = C bond) depends on the nature of the second substituent and its position with respect to the NCO group. Hydrogen atoms add to the NCO and NCS groups with opening of the N = C double bond. The site of addition (to the N or C atom) also depends on the nature of the second substituent. (auth)

27893 RADIOLYSIS OF TRIETHYLENEDIAMINEPLATINUM(IV) CHLORIDE. Shagisultanova, G. A.; Karaban, A. A. (Belorussian State Univ., Minsk). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 11, 1652-3(Nov 1971).

Translated from Zh. Fiz. Khim.; 45: No. 11, 2918-19(Nov 1971).

Radiolysis of aqueous solutions of the complex caused reduction of the central atom. The participation of H and e_{aq} species in the reaction and the major role of OH radicals in the process were confirmed. (M.C.G.)

27894 REACTIONS OF PULSE-RADIOLYSIS-PRODUCED $CH(^2\pi)$ WITH METHANE AND OTHER SUBSTANCES. Bosnali, M. W.; Perner, D. (Kernforschungsanlage, Juelich, Ger.). Z. Naturforsch.; 26a: No. 10, 1768-9(Oct 1971). (In German).

Either pure methane under various pressures or mixtures of methane with various compounds were excited by 600-kV electron pulses of 3 ns halftime. Kinetics of $CH(^2\pi)$ radicals were then determined by absorption spectroscopy. Time resolution of the experimental arrangement amounted maximally to about 2 ns. Results showed that CH radicals were formed immediately during the electron pulse; secondary formation was not observed. Rate constants for the reaction of CH with various compounds yielded approximately 5×10^{10} l/mole × s. The values were significantly higher than those reported in the literature. (H.B.G.)

27895 EFFECT OF ZINC OXIDE ON RADIATION-CHEMICAL PROCESSES IN AQUEOUS SOLUTIONS OF SILVER SALTS. Sviridov, V. V.; Kutsevich, N. I.; Branitskii, G. A. (Belorussian State Univ., Minsk). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 14: No. 8, 1133-6(1971). (In Russian).

Solutions of $AgNO_3$, Ag_2SO_4, and $AgClO_4$ (0.01 N) were given doses of ^{60}Co gamma radiation up to 10^7 R, both with and without ZnO sensitizer. Five different preparations of ZnO were used in this study. Radiolysis was not detected in the solutions of Ag^+ ion when ZnO was absent. Zinc oxide or hydroxide sensitized such solutions and promoted radiolysis. (K.S.W.)

27896 ACTIVATION ENERGY FOR RADIOTHERMOLUMINESCENCE OF ORGANIC SUBSTANCES. Nikol'skii, V. G.; Burkov, G. I. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 5, 373-7(Sep-Oct 1971).

Translated from Khim. Vys. Energ.; 5: No. 5, 416-21(Sep-Oct 1971).

The activation energy for radiothermoluminescence (RTL) of irradiated low-density polyethylene, technical paraffin, SKD cis-polybutadiene, 2,7-dimethyloctane, and cumene was investigated from 100°K to T_g by the method of initial rates. It was noted that E_{act} for RTL in the T_g range corresponds to the activation energy for β relaxation and to the activation energy for γ relaxation, determined from the temperature–frequency dependence, at lower temperatures. The RTL activation energy from 100 to 150°K for the investigated polymers and paraffin is 5 to 5.5 kcal/mole. It is shown that many of the low-temperature RTL maxima are anomalously broadened in connection with the nonuniform distribution of recombining ions with respect to the volume of the irradiated substance. The effect of the nonuniformity of the substance structure — the presence of time-relaxation spectra — on the activation energy for relaxation, determined by various methods, was examined. (auth)

27897 RADIOCHEMICAL SYNTHESIS AND PROPERTIES OF A CATION EXCHANGER BASED ON BIS-β,β'-CHLOROETHYL ESTER OF VINYLPHOSPHONIC ACID AND DIVINYLBENZENE. Tulupov, P. E.; Pashkov, A. B.; Slabkaya, L. D.; (and others). J. Appl. Chem. USSR (Engl. Transl.); 44: No. 9, 2061-6(Sep 1971).

Translated from Zh. Prikl. Khim.; 44: No. 9, 2029-35(Sep 1971).

It was shown that a cation exchanger can be synthesized by a radiochemical method with a high yield from bis-β,β'-chloroethyl ester of vinylphosphonic acid and divinylbenzene. The monomers were mixed, sealed, and subjected to γ radiation. The KF-R cation exchanger, containing alkylphosphonic groups, was appreciably inferior to KF-1 resin, which contained arylphosphonic groups, in resistance to radiation and heat treatment in water. The two resins were equal in chemical stability in 3 and 10 N HNO_3. (auth)

27898 RADIATION AND CHEMICAL STABILITY OF METHACRYLIC ACID–DIVINYLBENZENE COPOLYMERS. Semushin, A. M.; Galitskaya, I. P.; Kuzin, I. A. (Leningrad Technological Inst.). J. Appl. Chem. USSR (Engl. Transl.); 44: No. 9, 2067-71(Sep 1971).

Translated from Zh. Prikl. Khim.; 44: No. 9, 2035-9(Sep 1971).

Study of the influence of ^{60}Co gamma radiation on three specimens of KB-4 cation-exchange resin with different divinylbenzene (DVB) contents and containing different exchange ions showed that the stability of the resins increases with increasing DVB content because of a decrease of the moisture content in the resin, decreased probability of detachment of individual macromolecular chains, and the stabilizing influence of benzene nuclei in the resin matrix. The influence of exchange ions on the resistance of resins to radiation decreased with increasing degree of crosslinking. The chemical stability of irradiated resins during subsequent sorption–desorption cycles depended on the degree of crosslinking of the original copolymer, its ionic form (during irradiation), and the dose absorbed. (auth)

27899 STUDY OF THE ABSORPTION OF THE RADIATION OF THE ^{60}Co ISOTOPES BY CERTAIN PHARMACEUTICAL PRODUCTS. Velea, St.; Tamasdan, St.; Achimescu, Virginia; Danciu, Maria (Faculty of Pharmacy, Bucharest). Farmacia (Bucharest); 19: No. 6, 345-54(Jun 1971). (In Rumanian).

Acetylsalicylic acid, sodium salicylate, sulfathiazole, caffeine sodium benzoate, and phenylbutazone were exposed to a 1- to 2-μCi and a 40-mCi ^{60}Co source, in order to study the interaction of γ radiation of low and intermediate activity sources with these drugs. From the data, the linear attenuation coefficients of the investigated substances were determined as a function of the radiation intensity. The high-precision data yielded by the 40-mCi source were especially helpful to determine the physico-chemical properties of the materials. No radioinduced physico-chemical or pharmacodynamic changes were detected. The attenuation coefficients obtained were: sulfathiazole – 0.0261; phenylbutazone – 0.0145; caffeine sodium benzoate – 0.0283; sodium salicylate – 0.0273; and aspirin – 0.0160 cm^{-1}. (JPRS)

27900 RADIATION-CHEMICAL POLYMERIZATION OF VINYL FLUORIDE IN VARIOUS SOLVENTS. Gubareva, L. L.; Dordzhin, G. S.; Yul'chibaev, A. A.; Usmanov, Kh. U. (Tashkent State Univ.). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 14: No. 8, 1252-5 (1971). (In Russian).

The kinetics of radiation polymerization of vinyl fluoride was investigated both in bulk and in the solvents benzene, dimethylformamide, and dichloroethane, and at various temperatures from 43 to 0°C. All yield-time curves showing the extent of polymerization were linear because of the small amount (5 to 8%) of conversion to polymer that occurred under the conditions of the experiment. The total activation energy was 5.7 kcal/mole (bulk monomer), 4.8 to 5.3 kcal/mole in dimethylformamide, and 5.5 to 6.1 kcal/mole in dichloroethane. The polymerization rate in benzene was very small, and the E_{act} was not calculated. The polymerization rates were measured as a function of the dose rate, with the following results: $r = k(I)^{0.73}(M)^{2.7}$ for benzene; $r = k(I)^{0.76}(M)^{2.7}$ for dimethylformamide; $r = k(L)^{0.88}(M)^{1.2}$ for dichloroethane; where I = the dose rate in R/sec, and M = the monomer concentration. (K.S.W.)

27901 PROCESS FOR THE RADIATION GRAFTING OF 4-VINYL PYRIDINE ONTO POLYESTERS IN THE PRESENCE OF A POLYMERIZABLE UNSATURATED ORGANIC ACID. Sakurada, Ichiro; Okada, Toshio (to Japan Atomic Energy Research Inst.). U. S. Patent 3,649,494. 14 Mar 1972. Priority date 5 Sep 1967, Japan.

Polyester fiber material, which can be easily dyed with acidic, basic, direct or dispersed dyes, was obtained by graft-copolymerizing 4-vinylpyridine and a polymerizable unsaturated organic acid onto a polyester fiber material in an aqueous emulsified system by means of ionizing radiation. (Official Gazette)

27902 INITIAL STUDIES ON THE RADIATION INDUCED GRAFTING OF STYRENE TO POLYETHYLENE TEREPHTHALATE FIBERS. Vlagiu, I.; Stannett, V. (North Carolina State Univ., Raleigh); Rev. Roum. Chim.; 17: No. 1-2, 379-83(Jan-Feb 1972).

The kinetics of the radioinduced grafting of styrene to polyethylene terephthalate fibers was studied. A dose rate of 0.72 Mrads per hour of ^{60}Co radiation was used throughout at temperatures between 30 and 80°C. Dimethyl sulfoxide and water were used as swelling agents. The grafting rate was found to increase with temperature with an activation energy of 13.7 kcal/mole but reached a maximum in the vicinity of the glass transition temperature. The mechanism and kinetics of the grafting reaction are discussed in some detail. (auth)

27903 RADIATION CROSSLINKING OF POLY(VINYL CHLORIDE). Salmon, W. A.; Loan, L. D. (Bell Telephone Labs., Murray Hill, N. J.). J. Appl. Polym. Sci.; 16: No. 3, 671-82(Mar 1972).

The mechanism of the electron irradiation crosslinking of poly (vinyl chloride) (PVC) with polyfunctional acrylic monomers was investigated as part of a program to develop an insulation for distributing-frame wire. These monomers were found to undergo rapid polymerization to form a rigid, three-dimensional network onto which PVC was grafted. Polyfunctionality was necessary for crosslinking to occur, since butyl methacrylate, containing only a single unsaturated bond, did not crosslink readily. On the other hand, trimethylolpropane triacrylate and trimethylolpropane trimethacrylate, each containing three unsaturated groups, gave extremely rapid crosslinking. Trimethylolpropane triacrylate showed 40 times the radiation sensitivity of tetraethylene glycol dimethacrylate, a diunsaturated compound. The rate of disappearance of unsaturation was related inversely to the rate of gel formation. This was attributed to immobilization of unreacted pendant double bonds in the rigid crosslinked network. In the triunsaturated monomers, half the vinyl groups were left unreacted when all of the PVC was insoluble. (auth)

27904 ELECTRON SPIN RESONANCE AND PULSE RADIOLYSIS STUDIES OF THE REACTIONS OF OH AND O^- RADICALS WITH AROMATIC OLEFINIC COMPOUNDS. Neta, P. (Carnegie-Mellon Univ., Pittsburgh); Hoffman, Morton Z.; Simic, M. J. Phys. Chem.; 76: No. 6, 847-53(16 Mar 1972).

The reactions of OH and O^- radicals with several aromatic or unsaturated organic compounds in irradiated aqueous solutions were studied using both electron spin resonance and pulse radiolysis techniques. Each compound examined could react with the radical by addition to a double bond or aromatic ring or by hydrogen abstraction from an aliphatic chain. The relative yields of the radicals produced by the two possible mechanisms were compared at different pH values where either OH ($pK_a = 11.9$) or O^- is the main reacting radical. The results indicate that the rate of addition of O^- to an aromatic ring or to a double bond is much lower than that of OH, whereas the rates of hydrogen abstraction are comparable. For example, phenylacetic acid undergoes addition of OH to the ring but its reaction with O^- involves H abstraction from the CH_2 group. Similar results were obtained with diphenylacetic acid, o-, m-, and p-mehtylbenzoic acids, p-methoxybenzoic acid, benzyl alcohol, p-benzenedimethanol, p-phenylenediacetic acid, thymine, and crotonic acid. These findings also suggest the use of O^- for the production of radicals containing a double bond or an aromatic ring which cannot be produced by the reactions of OH or H since these latter radicals add to the unsaturated site in preference to abstraction. (auth)

27905 CERTAIN PROBLEMS POSED BY THE GRAFTING OF POLYMERS USING RADIOCHEMICAL METHODS. Chapiro, Adolphe (CNRS, Meudon, France). Rev. Gen. Caout. Plast.; 48: No. 11, 1217-22(Nov 1971). (In French). (CONF-690843-1).

From International symposium on macromolecular chemistry; Budapest, Hungary (25 Aug 1969).

The kinetics of grafting were examined in the case of the direct method involving irradiation of poly(tetrafluorethylene) films in the presence of the monomer to be grafted. The effect of temperature was established; the effect of the gel and the coefficients of auto-acceleration are being considered. Interesting differences were observed between the behavior of various monomers. Certain particularities of the radiochemical peroxidation stage encountered in the peroxidation method are treated; the conditions associated with the appearance of a hydroperoxidation chain reaction in the polymer (case when grafting an acrylic nitrile onto polypropylene) are considered. These results are compared to those obtained for the peroxidation of low-molecular-weight substances. (France)

27906 ROLE OF IONS IN RADIATION-INDUCED POLYMERIZATION. Schneider, C. (Univ., Cologne). Chem. Labor. Betr.; 21: No. 8, 337-47(1970). (In German).

A historical survey is given of the mechanistic approach to radioinduced polymerization. The evolutionary process of understanding the participation of ions in the mechanism of polymerization is outlined. (INIS)

27907 FORMATION OF CHROMIUM-CARBON BONDS IN AQUEOUS SOLUTION: A PULSE RADIOLYTIC STUDY. Cohen, H.; Meyerstein, D. (Nuclear Research Centre, Negev, Israel). J. Chem. Soc., Chem. Commun.; No. 6, 320-1(22 Mar 1972).

The specific rates of reaction of several aliphatic radicals with Cr^{2+} in aqueous solution were measured by a pulse radiolytic technique and correlated with the unpaired electron density on the reacting carbon atom. (auth)

27908 PARAMAGNETIC RELAXATION STUDY OF SPATIAL DISTRIBUTION OF TRAPPED RADICALS IN γ-IRRADIATED ALKALINE ICE AND ORGANIC GLASSES AT 4.2°K. Lin, D. P.; Hamlet, Peter; Kevan, Larry (Wayne State Univ., Detroit). (Contract AT(11-1)-2086. J. Phys. Chem.; 76: No. 8, 1226-7(13 Apr 1972).

The spatial distribution of trapped radicals in γ-irradiated 10M NaOH (alkaline ice), tetrahydro-2-methylfuran (MTHF), and triethylamine (TEA) was studied at 4.2°K by measuring the characteristic paramagnetic relaxation time vs radiation dose. Radical spur radii of <36 Å in alkaline ice, <34 Å in MTHF, and <37 Å in TEA are deduced from the data. These radii are smaller than the trapped electron spur radii measured previously in these same matrices. (auth)

27909 PRIMARY PRODUCTS OF THE RADIOLYSIS OF METHYL CYCLOHEXYL KETONE. Borisenko, G. L.; Revina, A. A.; Bakh, N. A. (Inst. of Electrochemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 3, 249-51(May-Jun 1971).

Translated from Khim. Vys. Energ.; 5: No. 3, 274-6(May-Jun 1971).

Results are reported that were obtained from liquid phase studies of the optical absorption spectra of products from the pulse radiolysis of degassed methyl cyclohexyl ketone, and solid phase observations of EPR spectra and optical absorption by products of steady γ irradiation, and also the effects produced on them by light of different wavelengths in the region $\lambda > 300$ nm. (D.H.M.)

27910 PULSE RADIOLYSIS OF THE TROPYLIUM ION, TROPYLCARBINOL, AND TROPILIDENE IN AQUEOUS SOLUTION. Schoeneshoefer, M. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch.; 26b: No. 11, 1120-4(Nov 1971). (In German).

The tropylium ion, $C_7H_7^{\oplus}$, is reduced by the H atom to yield the tropyl radical C_7H_7. C_7H_7 absorbs at 3150 Å with $\epsilon = 2800$ mole^{-1}

$l\ cm^{-1}$. The rate constant of the reaction $C_7H_7^+ + H \xrightarrow{H_2O} C_7H_7 + H_3O^\oplus$ is $(7 \pm 2)\ 10^9\ mole^{-1}\ l\ s^{-1}$. $C_7H_7^\oplus$ is also reduced by α-alcohol radicals but not by β-alcohol radicals. Tropylcarbinol C_7H_7OH reacts with e with $k = (6 \pm 2)\ 10^9\ mole^{-1}\ l\ s^{-1}$. The product is nonconducting and absorbs at 3150 Å with $\epsilon = 4200\ mole^{-1}\ l\ cm^{-1}$. This absorption is attributed to the hydroxycycloheptadienyl radical. (auth)

27911 INITIATION OF CYCLOHEXANOL OXIDATION WITH GAMMA RADIATION. Ladygin, B. Ya.; Furman, M. S. (State Scientific-Research and Design Inst. for the Nitrogen Industry and for Organic Synthesis Products, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 5, 405-9(Sep-Oct 1971).

Translated from Khim. Vys. Energ.; 5: No. 5, 454-8(Sep-Oct 1971).

The effects of temperature and dose strength were studied on the rate of the liquid-phase oxidation of cyclohexanol under the action of γ-radiation from ^{60}Co. The radiation oxidation of cyclohexanol acquires a chain-like character already at 0°C while the thermal, autooxidation is noticeable only at 100°C. The transition from the solid to the liquid phase is accompanied by a decrease in the oxidation rate because of the increase in the probability of recombination of the peroxide radicals. A mechanism is proposed for the cyclohexanol oxidation in which the reaction of the peroxide radicals with one another is the stage of chain continuation and the ratios are calculated for the reaction rate constants for the growth and rupture of the chain. (auth)

27912 PULSE RADIOLYSIS STUDY OF DIMER CATION FORMATION OF AROMATIC HYDROCARBONS IN BENZONITRILE SOLUTION. Kira, Akira; Arai, Shigeyoshi; Imamura, Masashi (Inst. of Physical and Chemical Research, Saitama, Japan). J. Phys. Chem.; 76: No. 8, 1119-24(13 Apr 1972).

Pulse radiolysis studies were made on several aromatic hydrocarbons in oxygenated benzonitrile solutions which were previously found to be appropriate for preparing solute cations. Absorption bands due to monomer cations were reduced with increase of the solute concentration, while corresponding increases in the intensity of the dimer cation bands were observed. Equilibrium constants for the dimer cation formation, $M^+ + M \rightleftharpoons M_2^+$, were evaluated to be 5.2×10^2, 1.7×10^2, 5.2×10, and $2.9 \times 10\ M^{-1}$ for naphthalene, perylene, 1,2-benzanthracene, and 9,10-dimethylanthracene, respectively, at 17° except for 1,2-benzanthracene at 20°. The tendency for stabilization was found to differ between the dimer cation formation and the excimer formation. (auth)

27913 ACTIONS CHIMIQUES ET BIOLOGIQUES DES RADIATIONS. (Chemical and Biological Effects of Radiations). Haissinsky, M. (ed.). Fifteenth Series. Paris; Masson et Cie, Editeurs (1971). 215p. (In French and English).

The fifteenth series consists of five chapters: pulse radiolysis of gases; radiolysis of liquid ammonia; radiation chemistry of frozen nonpolar and slightly polar systems; radioinduced polymerization by free ions; and action of ionizing radiations on colloidal systems. An abstract is included for each chapter. (France)

For abstracts of individual chapters see: 27914–27918.

27914 PULSE RADIOLYSIS OF GASES. Firestone, R. F.; Dorfman, L. M. (Ohio State Univ., Columbus). pp 7-46 of Actions Chimiques et Biologiques des Radiations. /Haissinsky, M. (ed.). Paris; Masson et Cie, Editeurs (1971).

Developments in the pulse radiolysis technique led to applications of this fast reaction method in radiochemistry, radiobiology, solution kinetics, and the spectroscopy of transient species. The impulse method permits direct, time-resolved observation of the reactive species to be made. Experimental methods, dosimetry, reactions of oxygen atoms, reactions of hydrogen atoms, reactions of electrons and ions, and spectroscopic studies of growth and decay of transient intermediates for rare gases and molecular gases are considered. (30 references) (France)

27915 RADIOLYSIS OF LIQUID AMMONIA. Belloni, J. (Institut du Radium, Paris). pp 47-80 of Actions Chimiques et Biologiques des Radiations. /Haissinsky, M. (ed.). Paris; Masson et Cie, Editeurs (1971). (In French).

The radiolysis of liquid ammonia (pure or in the presence of mineral or organic solutes) by x or γ rays, electrons, or high LET particles (α, ^7Li, fission fragments) is discussed. The primary ionization mechanisms of the ammonia molecule and successive reactions leading to radicals, ions, or stable species are described. The primary yields, molecular yields, and radical yields obtained in radiolysis with γ and x rays and electrons are presented. (70 references) (France)

27916 RADIATION CHEMISTRY OF FROZEN NONPOLAR AND SLIGHTLY POLAR SYSTEMS. Kevan, Larry (Wayne State Univ., Detroit). pp 81-143 of Actions Chimiques et Biologiques des Radiations. /Haissinsky, M. (ed.). Paris; Masson et Cie, Editeurs (1971).

This review concerns frozen nonpolar and slightly polar systems. It includes: ethers, e.g., 2-methyltetrahydrofuran (MTHF), 1,1-dimethoxyethane (DME), isobutyl vinyl ether (IBVE), diethyl ether, 1,3-dioxalane; amines and cyanides, e.g., triethylamine (TEA); ketones, e.g., acetone; alkenes, e.g., 2-methyl-1-pentene (2MP-1); and alkanes, e.g., 3-methylpentane (3MP), 2-methyltetrahydrofuran, and 3-methylpentane. Structure and physical properties, trapped species at and below 77°K, scavenger effects, solute effects, photoionization of solutes, thermal decay, luminescence decay, radical yields, and spatial distribution of trapped species are discussed. (88 references) (France)

27917 RADIATION-INDUCED POLYMERIZATION BY FREE IONS. Hayashi, Koichiro (Hokkaido Univ., Sapporo). pp 145-83 of Actions Chimiques et Biologiques des Radiations. /Haissinsky, M. (ed.). Paris; Masson et Cie, Editeurs (1971).

Radioinduced ionic polymerizations are initiated through intermediates (e.g., cation–radical, anion–radical, or protonated molecule). These active species were directly observed by mass spectrometry, ion cyclotron resonance, pulse radiolysis, electric conductivity measurements, ESR, electron spectra, and radiothermoluminescence. After a brief description of some results obtained by these methods, the initiation mechanisms of radioinduced ionic polymerizations of various monomers such as styrene, isobutene, nitroethylene, vinyl ethers, and trioxane are discussed. (48 references) (France)

27918 ACTION OF IONIZING RADIATIONS ON COLLOIDAL SYSTEMS. Haissinsky, M. (Institut du Radium, Paris). pp 185-202 of Actions Chimiques et Biologiques des Radiations. /Haissinsky, M. (ed.). Paris; Masson et Cie, Editeurs (1971). (In French).

The difficulties encountered and the positive results acquired in studying the physicochemical modifications undergone by irradiated colloidal solutions are presented. The stability variations of hydrosols are considered. The chemical transformations are mentioned to explain the stability results. The investigation is divided into two parts: mineral colloids and organic colloids. The principal results on irradiated mineral colloids are presented in a table. (44 references) (France)

27919 CHANGE IN ABSORPTION AND FLUORESCENCE IN SOLUTIONS OF INSULIN AND TYROSINE IN THE ULTRAVIOLET REGION OF THE SPECTRUM ON EXPOSURE TO IONIZING RADIATIONS. Bezrukova, A. G.; Palatov, V. A. (Central Roentgeno-Radiological Research Inst., Leningrad). Biophysics (USSR) (Engl. Transl.); 16: No. 3, 563-7(1971).

Translated from Biofizika; 16: No. 3, 541-4(1971).

The uniform character of change in the absorption and fluorescence spectra of solutions of insulin and tyrosine was established in relation to the dose of γ radiation (5, 10, 25, 50, 100, 200, 500, and 1000 kr) for different pH values of the irradiated solutions. It was assumed that the changes in the spectroscopic properties of insulin were associated with disturbance in the tyrosine amino acid residues on exposure to radiation. (auth)

27920 FIRST INDUSTRIAL PROCESS OF RADIATION SYNTHESIS: PRODUCTION OF TETRABROMOXYLENE. Plander, E.; Zahalka, J. (Vyrobu a Vyuziti Radioisotopu, Prague). Radioisotopy; 13: No. 2, 371-80(1972). (In Czech).

The mechanism and kinetics of radioinduced bromination are described, with special attention to the bromination of p-xylene. The product, $\alpha,\alpha,\alpha',\alpha'$-tetrabromo-p-xylene lends self-extinguishing properties to plastic materials, namely to foam polystyrene. An experimental plant for the radioinduced synthesis of this bromoderivative of p-xylene is reported. (auth)

27921 ELECTRON SPIN RESONANCE STUDY OF HIGH ENERGY RADIATION DAMAGE IN TETRAPOTASSIUM HEXACYANORUTHENATE TRIHYDRATE, $K_4Ru(II)(CN)_6.3H_2O$. Eachus, R. S.; Herring, F. G. (Univ. of British Columbia, Vancouver). Can. J. Chem.; 50: No. 2, 162-6(15 Jan 1972).

Gamma irradiation at 77°K and x irradiation at room temperature of single crystals of the diamagnetic tetrapotassium hexacyanoruthenate trihydrate produce a number of interesting paramagnetic species. At room temperature the esr spectra can be interpreted in terms of the species $[Ru(CN)_5(NC)]^{5-}$. At liquid nitrogen temperature the species $[Ru(CN)_4(NC)_2]^{5-}$ is observed and the HCN^- radical is produced in an environment that does not permit it to rapidly reorientate at 77°K. The HCN^- radical is believed to be in close association with a ruthenium(II) ion. (auth)

27922 ESR STUDY OF THE CHLOROFLUOROACETAMIDE RADICAL IN IRRADIATED DICHLOROFLUOROACETAMIDE SINGLE CRYSTALS. Kispert, Lowell D.; Myers, Fred Jr. (Univ. of Alabama, University). J. Chem. Phys.; 56: No. 6, 2623-31(15 Mar 1972).

The electron spin resonance spectra of single crystals of dichlorofluoroacetamide and N,N-dideuterodichlorofluoroacetamide irradiated with x rays at 77°K and later warmed to 170°K, were assigned to $\cdot CClFCONH_2$ and $\cdot CClFCOND_2$, respectively. A tensor Hamiltonian fit to the spectra yielded either complete or partial hyperfine splitting tensors for fluorine-19, chlorine-35, carbon-13, and nitrogen-14 in addition to the chlorine-35 quadrupole coupling and the g tensor. These results along with a CNDO/2 molecular orbital calculation indicates that the $\cdot CClFCONH_2$ radical is a planar π radical. An INDO molecular orbital calculation was carried out for the $\cdot CH_2CONH_2$, $\cdot CFHCONH_2$, and $\cdot CF_2CONH_2$ radicals in order to interpret the experimentally observed amide nitrogen and proton splitting variations. (auth)

27923 RADIATION-INDUCED GRAFT COPOLYMERIZATION OF STYRENE TO CELLULOSE. Guthrie, J. T.; Huglin, M. B.; Phillips, G. O. (Univ. of Salford, Eng.). J. Appl. Polym. Sci.; 16: No. 4, 1017-37(Apr 1972).

The radioinduced graft copolymerization of styrene to cellulose was studied in vacuo at 30°C and at dose rates from (0.37 to 8.73) $\times 10^{-2}$ W/kg. Dioxane was used as solvent for monomer and polystyrene homopolymer, and water (2% total volume) was incorporated as swelling agent for cellulose. The concentration of styrene in the bulk medium was varied from 0.432 to 3.46 moles/l and the rates of both grafting and homopolymerization were proportional to [monomer] · [intensity]$^{\frac{1}{2}}$. The value of 3.3×10^{-4} l mole^{-1} sec^{-1} derived for k_p^2/k_t in homopolymerization was similar to that for normal free radical polymerization of styrene. However, reduced termination during grafting yielded a much higher value (58 l moles^{-1} sec^{-1}). Degradation of cellulose in the absence of monomer was followed viscometrically, and values of 13.5 and 24.6 were derived for G(scission) in vacuo and in air, respectively. (auth)

27924 GRAFT COPOLYMERIZATION OF ACRYLIC ACID TO NYLON 6 MUTUAL IRRADIATION. II. THE INFLUENCE OF CUPRIC IONS. Huglin, M. B.; Johnson, B. L. (Univ. of Salford, Eng.). J. Appl. Polym. Sci.; 16: No. 4, 921-8(Apr 1972).

In the γ-irradiation in vacuo of nylon 6 film in the presence of aqueous acrylic acid and different concentrations of cupric chloride, the following relationships were obtained: $R_H \propto [CuCl_2]^{-1.0}$ and $R_G \propto [CuCl_2]^{-0.3}$. Here $[CuCl_2]$ is the concentration of cupric chloride in the bulk solution, and R_H and R_G denote the initial rates of homopolymerization and grafting, respectively. The values of –1.0 and –0.3 for the exponents indicate that the cupric ion is a less effective chain terminator in the film on account of its lower concentration there. Analyses of films grafted in different media demonstrate the copper content of a film to be independent of both the concentration of monomer in the solution and the degree of swelling. The copper content is primarily a function of the total poly(acrylic acid) present, i.e., grafted species plus occluded homopolymer. Thus, at high doses, where the total poly (acrylic acid) associated with a film is significant, the grafting curves exhibit a falling off, and complex formation between cupric ion and a growing chain is considered a likely contributory factor. (auth)

27925 PARAMAGNETIC RESONANCE OF X-RAY-IRRADIATED RUBIDIUM AZIDE. Owens, F. J. (Feltman Research Lab., Dover, N. J.). Phys. Status Solidi (b); 49: No. 2, K125-8(1 Feb 1972).

An ESR study of a neutral N atom trapped in x-irradiated RbN_3 is reported. Both the irradiation and the ESR observations were carried out at 77°K, and the spectrum can be described by a spin Hamiltonian for $S = \frac{3}{2}$ with an isotropic g-value close to the free electron value. Hence, the spectrum is assigned to the $^4S_{\frac{3}{2}}$ ground state of the neutral N atom. The ESR parameters of the N^0 in RbN_3 are compared with these for N^0 in the other azides. It is suggested that covalency contributes to the zero-field splitting. (D.L.C.)

Radiochemistry and Nuclear Chemistry

Refer also to abstracts 27856 and 29175.

27926 (JPRS-55491) MODERN TRENDS IN NUCLEAR CHEMISTRY. Gol'danskii, V. I. Translated from Fiz. Szemle; 21: No. 11, 329-37(1971). 17p. NTIS.

27927 CONTRIBUTIONS TO RING OVEN METHODOLOGY. IX. COMPLEXOMETRIC ACTIVITY DETERMINATION OF RADIONUCLIDES ON THE BASIS OF RING-SHAPED AUTORADIOGRAM. Grdinic, V. (Univ., Zagreb). Mikrochim. Acta; No. 1, 14-19 (1972). (In German).

A method was developed for the quantitative activity determination of radionuclides. Following separation on the ring oven, the activity of the radionuclides is measured by an autoradiographic procedure on a Roentgen film. The total reduced silver of the film is exchanged by CuS and titrated complexometrically. Results show that the amount of the precipitated silver (M_r) stands in linear relationship to the specific dosage of the radionuclide (E) present. The results were analyzed statistically. (auth)

27928 CONTRIBUTIONS TO RING OVEN METHODOLOGY. X. QUANTITATIVE DETERMINATION OF INHOMOGENEOUSLY DISTRIBUTED RADIONUCLIDES ON THE CAPILLARY CARRIER. THEIR USE IN CHROMATOGRAPHY. Grdinic, V.; Gertner, A. (Univ., Zagreb). Mikrochim. Acta; No. 1, 20-3(1972). (In German).

It was found that the activities of radionuclides can be quantitatively determined on capillary carriers without taking into account the form and size of the flecks in which the radionuclide is contained. The thickness, the surface weight, and the pore diameter of the capillary carrier do not affect the analytical findings within certain limits. Therefore, the suggested method can be employed in the ring oven technique as well as in paper- and thin-layer chromatography. (auth)

27929 EXPERIENCE IN THE OPERATION OF PORTABLE LABORATORIES FOR FIELD USE. Wessman, R.; Beeman, W.; Leventhal, L. (TRAPELO/WEST, Richmond, Calif.). pp 459-70 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

Trapelo–West has for some years maintained a complete portable radiochemical laboratory manned by an experienced radiochemist and radiometrics technician. This laboratory is contained in two boxes but delicate equipment is carried by the personnel. The laboratory can be and has been shipped by air to destinations in and outside the continental limits of the United States of America. The equipment comprises laboratory equipment and supplies such as centrifuges, glassware, reagents, and radiometric equipment comprising both beta-counting equipment and multichannel pulse height analysis instruments. Common laboratory items and facilities are usually available at site, or in an emergency can be dispensed with. With this equipment, which can be set up in any 30 m^2 working space, most of the important radionuclides may be accurately assayed. Data readout is available within minutes. Most procedures are adaptable for use under these field conditions. This equipment is stored, when not in use, and is instantly ready for field operations, as required. As a result, a portable field laboratory of this type with trained personnel is recommended as a possible solution to accidents requiring rapid assessment data. (auth)

Hot-Atom Chemistry

27930 GAS-PHASE AROMATIC SUBSTITUTIONS BY BROMINIUM IONS FROM THE ISOMERIC TRANSITION OF ^{80m}Br. Cacace, Fulvio; Stoecklin, Gerhard (Univ., Rome. Kernforschungsanlage, Juelich, Ger.). J. Amer. Chem. Soc.; 94: No. 7, 2518-20(5 Apr 1972).

Preliminary results are presented of a study on gas-phase bromination of benzene, toluene, and the halobenzenes by brominium ions resulting from the isomeric transition of ^{80m}Br in $CH_3{}^{80m}$Br. There was evidence against a contribution from thermal bromine atoms and radiolytic processes. A reaction scheme is suggested. (M.C.G.)

Properties of Radioactive Materials

27931 (ORNL-TM-3728) SEARCH FOR LASER PHENOMENA IN THE ACTINIDES: STUDIES OF INVESTIGATIONS OF Am^{3+} IN LIQUID $POCl_3$. Friedman, H. A.; Bell, J. T. (Oak Ridge National Lab., Tenn.). 25 Feb 1972. Contract W-7405-eng-26. 13p. Dep. NTIS.

The chemistry and the spectral properties of Am^{3+} indicated that this actinide had laser potentiality. Techniques for the preparation of solutions of americium in $POCl_3$–$ZrCl_4$ and efforts to make these solutions show laser activity are described. Failure of these efforts is attributed to the short lifetime for the excited state of Am^{3+}. The results for americium in $POCl_3$–

$ZrCl_4$ are compared with those obtained for americium in a $CaWO_4$ host matrix. (auth)

27932 (SRARI-P-109) AMERICIUM, CURIUM, AND PROMETHIUM TRIVALENT IONS. COMPLEXING WITH ETHYLENEDIAMINE-bis-METHYLPHOSPHONOUS ACID. Elesin, A. A.; Zaitsev, A. A.; Sergeev, G. M.; Nazarova, I. I. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The complexing of trivalent americium, curium, and promethium ions with ethylenediamine-[bis-(methylphosphonic)] acid (EDMPA) at an ion strength of 0.5 and temperature of 25°C was investigated by ion exchange on KY-2 type cationite. At pH 7 $M(H_2A)^+$ complexes formed. This was confirmed by pH-potentiometry data where M = A^{3+}, C^{3+}, P^{3+}, and H_2A is a doubly charged anion of EDMPA. The stability constants values of americium, curium, and promethium are 1.3×10^6, 2.5×10^6, and 6×10^5, respectively. On the cationite column curium is eluted with only an insignificant lead of americium, which indicates the proximity of their stability constant values. (auth)

27933 (SRARI-P-115) KINETICS AND MECHANISM OF AMERICIUM(III) INTERACTION WITH PEROXYDISULFATE IONS IN POTASSIUM CARBONATE SOLUTIONS. Ermakov, V. A.; Rykov, A. G.; Timofeev, G. A.; Dzhadav, A. V.; Yakovlev, G. N. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The kinetics of Am(III) reactions with persulfate ions in 1.30 to 2.50M K_2CO_3 solutions at 58 to 83°C were studied. The oxidation rate for Am(III) is defined by the thermal decomposition of $S_2O_8^{2-}$ ions and occurs through the intermediate Am(V) accumulation. A kinetic scheme describing the influence of reactant concentrations, composition, and solution temperature on the rate of oxidation is proposed. (auth)

27934 CHEMI-IONIZATION IN COLLISIONS OF URANIUM ATOMS WITH OXYGEN ATOMS AND MOLECULES. Fite, Wade L.; Irving, Philip (Extranuclear Labs., Inc., Pittsburgh). J. Chem. Phys.; 56: No. 8, 4227-8(15 Apr 1972).

The two chemi-ionization processes $U + O \rightarrow UO^+ + e$ and $U + O_2 \rightarrow UO_2^+ + e$ were observed in a crossed beam experiment. Results indicated that the ratio of cross sections for the first reaction to the second reaction has a value of 97(±20). (M.C.G.)

27935 HYDRATION OF IONS INVESTIGATED BY ELECTRICAL CONDUCTIVITY MEASUREMENTS. III. HYDRATION OF SINGLY AND DOUBLY CHARGED CATIONS IN ACID PERCHLORATE SOLUTIONS. Gusev, N. I. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 9, 1268-71(Sep 1971).

Translated from Zh. Fiz. Khim.; 45: No. 9, 2243-6(Sep 1971).

Since the maximum in the isothermal variation of electric conductivity with acid concentration was attributed to a deficiency of free water, investigations were made of solutions of metal perchlorates in aqueous perchloric acid, and the numbers of water molecules coordinated by the cations were established. Li^+ and Na^+ (n = 2.5 to 3.5); Be^{2+} (~4); Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Ni^{2+}, and UO_2^{2+} (7 to 8). The role of association and the exchange of water are discussed. (auth)

27936 CHEMISTRY OF THE URANYL GROUP. PART IV. PREPARATION AND PROPERTIES OF TRIPHENYL-PHOSPHINE AND -ARSINE OXIDE COMPLEXES OF URANYL DITHIOACETATE AND DITHIOBENZOATE, AND THE STRUCTURE OF BIS(DITHIOACETATO)DIOXO-(TRIPHENYLPHOSPHINE OXIDE) URANIUM(VI). Bombieri, G. (CNR, Padua); Croatto, U.; Forsellini, E.; Zarli, B.; Graziani, R. J. Chem. Soc., Dalton Trans.; No. 4, 560-4(1972).

Monomeric complexes of the formulas $UO_2(MeCS_2)_2L$ and $UO_2(PhCS_2)_2L$ (L = Ph_3PO and Ph_3AsO) were synthesized and characterized. The crystal structure of $UO_2(MeCS_2)_2(Ph_3PO)$ was determined from three-dimensional counter data by Patterson and electron-density syntheses and refined by least-squares to R 0.077 for 3924 reflections. The crystals are monoclinic, space-group $P2_1/c$, with a = 16.728 Å, b = 11.001 Å, c = 15.678 Å, $\beta = 113° 29'$, Z = 4. The uranium(VI) atom is in a seven-coordinate, pentagonal-bipyramidal environment. The linear uranyl group is perpendicular to the equatorial plane in which four sulfur atoms of two dithioacetate groups and the oxygen atom of the ligand occupy the corners of an irregular pentagon. (auth)

27937 SOME ASPECTS OF FLUORINE CHEMISTRY. Bougon, R. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 161, 9-16(Jul-Aug 1971). (In French).

The main types of synthesis reactions used in fluorine chemistry are reviewed briefly. Some experiments involving the synthesis of new complexes, such as Na_2NiF_6, $AgUF_6$, or compounds such as NOF_3 and $ClOF_3$, are described. It is sometimes necessary to excite the fluorine or fluorinating agent. The two processes used for this purpose (subjecting the fluorine to pressure; exposure to uv radiation) are briefly described. The research methods used in fluorine chemistry and the corresponding analytical techniques are described. (France)

27938 COMPLEXES OF DOUBLY CHELATING LIGANDS. PART IV. NICKEL(II), ZINC(II), MAGNESIUM(II), AND URANYL (VI) COMPLEXES OF L-β-(3,4-DIHYDROXYPHENYL)-ALANINE (DOPA). Gorton, J. E.; Jameson, R. F. (Univ. of Dundee, Scotland). J. Chem. Soc., Dalton Trans.; No. 3, 310-12(1972).

The interactions of DOPA with nickel(II), zinc(II), magnesium(II), and uranyl(VI) ions in aqueous solution were investigated at 25° ± 0.01° and 1.0M-ionic strength (KNO_3) by potentiometric and spectrophotometric methods. The stoichiometry and nature of the chelate reactions were established and stability constants are reported for nickel, zinc, and magnesium complexes. Mixed metal complex systems were also studied for the DOPA–uranyl–copper system. Interpretation of these systems was limited by precipitation and olation reactions of the complexes. (auth)

27939 COMPARATIVE STABILITY OF COMPLEX COMPOUNDS OF YTTRIUM, SOME RARE EARTHS, AND ACTINIDE ELEMENTS WITH ANIONS OF OXALIC, CITRIC, ETHYLENEDIAMINETETRAACETIC, AND 1,2-DIAMINOCYCLOHEXANE-TETRAACETIC ACIDS. Stepanov, A. V. Zh. Neorg. Khim.; 16: No. 11, 2981-5(Nov 1971). (In Russian).

The composition and stability constants of oxalate and citrate complexes of La, Ce, Pm, Eu, Tb, Tm, Y, Am, Cm, Bk, and Cf were determined in acid solutions at an ionic strength of 0.1 and at 25°C. The ratios of the first stability constants of the complexes to the corresponding constant for Eu were measured for: La, Ce, Pm, Eu, Tb, Tm, Yb, Lu, Y, Ac, Am, Cm, Bk, and Cf with citric, oxalic, (ethylenedinitrilotetraacetic) and (1,2-cyclohexylenedinitrilo)tetraacetic acids. The dependence of $\Delta \lg k_1$ on the reciprocal of the ionic radius was examined, and certain stability features of complexes of elements having f-electrons and relative to Y, La, and Ac are discussed. (tr-auth)

27940 LITHIUM POLYURANATES. Kovba, L. M. (Moscow State Univ.). Zh. Neorg. Khim.; 16: No. 11, 3089-91(Nov 1971). (In Russian).

The system $Li_2UO_4-U_3O_8-O_2$ was studied at 750 to 900°C by a radiographic method. It was shown that Li diuranate does not exist. In the $Li_2UO_4-UO_3$ system four compounds were identified: $Li_2O \cdot 1.60$ to $1.64UO_3$; $Li_2O \cdot 1.75UO_3$; $Li_2O \cdot 3UO_3$; and $Li_2O \cdot 6UO_3$. (K.S.W.)

27941 INFRARED AND LUMINESCENCE SPECTRA OF NITRATOHALOGENIDES OF TETRA- AND PENTACARBAMIDOURANYL. Ellert, G. V.; Tsapkina, I. V.; Evstaf'eva, O. N.; Zolin, V. F.; Fisher, P. S. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim.; 16: No. 11, 3092-7 (Nov 1971). (In Russian).

The following complexes were studied by means of ir and luminescence spectra: $[UO_2 \cdot 4CO(NH_2)_2H_2O]X_y(NO_3)_{2-y}$, where X = I^- (y = 1.1; 1.7) or X = Br^- (y = 1); or X = Cl^- (y = 0.5); and $[UO_2 5CO(NH_2)_2]X \cdot NO_3$, where X = I^- or Cl^-. The existence of urea in the inner sphere and nitrate ions in the outer sphere of the complex compounds is discussed. (tr-auth)

27942 SOLUBILITY PRODUCTS OF THE HYDROXIDES OF RADIOACTIVE ELEMENTS. Pavlov-Verevkin, B. S. Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 11, 1583-4(Nov 1971).

Translated from Zh. Fiz. Khim.; 45: No. 11, 2792-5(Nov 1971).

A method is proposed for determination of the solubility products of hydroxides consisting in the measurement of the residual concentrations of the metal investigated using a radioactive tracer at different ionic strengths and extrapolation of the results to an ionic strength of zero. Under these conditions, the solubility product is equivalent to the activity products of the ions of the hydroxide investigated. The solubility product of iron(III) hydroxide determined by this method is 3.5×10^{-34}. The applicability of the method in the calculation in the solubility product of uranyl hydroxide was demonstrated, the value obtained agreeing with handbooks. (auth)

27943 MEASUREMENT OF THE CHARGE ACCUMULATED IN RADIOACTIVE DIELECTRIC MATERIALS. Gromov, V. V.; Oziraner, S. N.; Spitsyn, Vikt. I.; Minaev, A. A. (Inst. of Physical Chemistry, Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 11, 1589-91(Nov 1971).

Translated from Zh. Fiz. Khim.; 45: No. 11, 2804-8(Nov 1971).

The charge accumulated in the surface layer on radioactive dielectric materials (strontium sulfate and glass containing ^{90}Sr was measured. The charge is proportional to the specific radioactivity and inversely proportional to the specific conductance of the dielectric material. The measured charges are 5.5×10^{-11} and 1×10^{-9} C cm^{-3} for strontium sulfate and the glass, respectively. (auth)

27944 KINETICS OF THE REDUCTION OF NEPTUNIUM(VI) TO NEPTUNIUM(V) BY HYDRAZINE. Koltunov, V. S.; Tikhonov, M. F. Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 11, 1640-1(Nov 1971).

Translated from Zh. Fiz. Khim.; 45: No. 11, 2900-1(Nov 1971).

The kinetics of reduction of hexavalent neptunium to the quinquevalent state by hydrazine were studied in perchloric acid solutions of ionic strength $\mu = 4$. The reaction is of the first order in Np(VI) and N_2H_4. The order of the reaction with respect to H^+ ions is −1.5. The activation energy is 16.7 kcal $mole^{-1}$. A reaction mechanism is proposed, including two slow steps in the reaction between hydrolyzed forms of Np(VI) and $N_2H_5^+$ ions. (auth)

27945 REVERSIBLE DISMUTATION OF UO_2(V) IN THE MOLTEN LiCl–KCl EUTECTIC. II. Landresse, G.; Duyckaerts, G. (Univ., Liege). Anal. Chim. Acta; 59: No. 1, 101-10(Mar 1972). (In French).

The disproportionation of UO_2(V) in LiCl–KCl eutectic at 450°C was studied as a function of the pressure of hydrogen chloride in a wide range by visible and near infrared absorption spectrophotometry. As important errors affect the measurements at low pressure, no precise conclusions can be drawn. A previous study limited to a pressure range where precision was satisfactory indicated that the following reaction occurred: $2\ UO_2^+ + 4\ HCl \rightleftharpoons UO_2^{2+} + U^{4+} + 2\ H_2O + 4\ Cl^-$. On the basis of complementary measurements, the following equilibria must be taken into account: $2\ UO_2^+ + 2\ HCl \rightleftharpoons UO_2^{2+} + U^{4+} + 2\ OH^- + 2\ Cl^-$ and $2\ UO_2^+ + 6\ HCl \rightleftharpoons UO_2^{2+} + U^{4+} + 2\ H_3O^+ + 6\ Cl^-$, and it seems that the contribution of the first reaction is relatively small. (auth)

27946 STUDY OF THE IR AND RAMAN SPECTRA OF POTASSIUM DIOXOPENTAFLUOROURANATE. VI. CONVENTIONAL COORDINATE ANALYSIS OF THE PENTAGONAL BIPYRAMIDAL $UO_2F_5^{3-}$ ION. Wendling, Edgar; Mahmoudi, Saad. Bull. Soc. Chim. Fr.; No. 1, 40-6(Jan 1972). (In French).

For the first time, the complete vibrational spectrum (ir and Raman from 4000 to 33 cm^{-1}) is given for the $UO_2F_5^{3-}$ ion, which has an approximately pentagonal bipyramidal symmetry (potassium dioxopentafluorouranate(VI)). A conventional coordinate analysis using the logarithmic step method in the framework of the generalized valence force field leads to accurate assignments for the fundamental and combination bands. The following constants were obtained for the U–F and U–O bonds: stretching force 1.33 and 6.11 millidynes/A; mean vibration amplitudes 0.0655 and 0.0375A (at 298°K); bond orders 0.62 and 2.30. The bonds between the F ligands and the uranyl groups are, thus, essentially of an electrostatic nature. An empirical relation was established allowing the mean lengths of the U–O and U–F fluorine bonds to be calculated with an accuracy of ±0.03A. (France)

27947 SYNTHESIS AND STUDY OF THE PROPERTIES OF URANIUM DIPHTHALOCYANINE. Kirin, I. S.; Kolyadin, A. B.; Moskalev, P. N. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Neorg. Khim.; 16: No. 10, 2731-5(Oct 1971).

The adducts $UCl_4 \cdot (C_2H_5)_3N$ and $UO_2(NO_3)_2 \cdot 2(C_2H_5)_3N$ were prepared and allowed to react with o-phthalonitrile in a molar ratio of 1:10 in an atmosphere of Ar at 300 to 350°C for 30 to 40 min. The reaction product, uranium diphthalocyanine, was purified by fractional sublimation at 580 to 590°C in a vacuum with a 5°/min gradient, obtaining dark violet crystals, $U(C_{32}H_{16}N_8)_2$. X-ray powder diffraction patterns and an ir spectrum (2,000 to 700 cm^{-1}) were obtained, and the stability of the U complex was demonstrated. (K.S.W.)

27948 COMPLEX COMPOUNDS OF URANYL FLUORIDE WITH WATER AND HF. Seleznev, V. P.; Tsvetkov, A. A.; Khozhainov, Yu. M. (Moscow Chemical Tech. Inst.). Zh. Neorg. Khim.; 16: No. 10, 2876-7(Oct 1971). (In Russian).

With UO_3, HF, and H_2O as the starting materials, the following complex compounds were synthesized: $UO_2F_2 \cdot 2HF \cdot 4H_2O$, $UO_2F_2 \cdot 1.3HF \cdot 3.5H_2O$, $UO_2F_2 \cdot 1.03HF \cdot 2.08H_2O$, $UO_2F_2 \cdot 1.91HF \cdot 4.02H_2O$, and $UO_2F_2 \cdot HF \cdot 2H_2O$. X-ray data are given for the first and last of this series of complex compounds. (K.S.W.)

27949 FORMS OF U(IV) AND Np(IV) IN NITRATE SOLUTIONS. Rykov, A. G.; Vasil'ev, V. Ya.; Vlokhin, N. B. Zh. Neorg. Khim.; 16: No. 10, 2892-3(Oct 1971). (In Russian).

Both U(IV) and Np(IV) exhibit only three individual absorption spectra in nitrate solution, and consequently exist in only three forms, differing in the structure of the first coordination sphere of the U(IV) or Np(IV) ions. An analysis of the optical density curves is made in terms of the formation of a nitrate complex: $M^{4+} + nNO_3^- \rightleftharpoons M(NO_3)_n^{4-n}$. (K.S.W.)

27950 STRUCTURE OF URANIUM BOROHYDRIDE BY SINGLE-CRYSTAL X-RAY DIFFRACTION. Bernstein, E. R. (Princeton Univ., N. J.); Keiderling, T. A.; Lippard, S. J.; Mayerle, J. J. J. Amer. Chem. Soc.; 94: No. 7, 2552-3(5 Apr 1972).

Dark green crystals of $U(BH_4)_4$ were grown by vacuum sublimation and sealed in capillaries under nitrogen. The unit cell parameters are $a = 7.49 \pm 0.01$ and $c = 13.24 \pm 0.01$ Å. The uranium atom occupies special position (4a) of site symmetry 2. The structure is polymeric, consisting of interlocking helical chains in which individual units are related by a fourfold screw axis. There are 6 tetrahydroborate groups associated with each uranium atom. (M.C.G.)

27951 ELECTROCHEMICAL STUDIES OF THE INTERACTIONS OF RIBOFLAVIN AND OF ITS REDUCTION PRODUCTS WITH METAL IONS IN DIMETHYL SULFOXIDE. Sawyer, Donald T.; McCreery, Richard L. (Univ. of California, Riverside). Inorg. Chem.; 11: No. 4, 779-82(Apr 1972).

The nonaqueous electrochemistry of riboflavin and its reactions with metal ions were studied at a platinum electrode in dimethyl sulfoxide. Cyclic voltammetry, chronopotentiometry, and controlled-potential electrolysis were used to establish that riboflavin is reduced in neutral solutions by two one-electron steps with a stable anion radical produced by the first of these; under acidic conditions it is reduced by a single two-electron process. The interactions of the riboflavin radical anion with iron(II), nickel(II), yttrium(III), lanthanum(III), thorium(IV), calcium(II), and sodium(I) ions were investigated and the relative stabilities of the resulting complexes were determined. Disproportionation of the radical anion appears to be promoted by the higher valent metal ions. (auth)

27952 INFRARED ABSORPTION SPECTRA OF SOME NEPTUNIUM COMPOUNDS. Kharitonov, Yu. Ya.; Moskvin, A. I. Dokl. Akad. Nauk SSSR; 200: No. 3, 613-16(21 Sep 1971). (In Russian).

The infrared absorption spectra of a number of compounds of Np(IV, V, VI) with OH^-, NO_3^-, $C_2O_4^{2-}$, and CO_3^{2-} groups were studied for the purpose of establishing the bonding character of the groups and their influence on the Np–O bonds in the neptunyl(NpO_2(II)) and neptunoyl(NpO_2(I)) radicals. Compounds reported include $Cs_2Np(NO_3)_6$, $Na_4Np(CO_3)_4 \cdot x\ H_2O$, $NpO_2CO_3 \cdot x\ H_2O$, and $NH_4NpO_2CO_3 \cdot x\ H_2O$. (K.S.W.)

27953 STUDY OF EQUILIBRIA IN THE SYSTEMS $US_x - Br_2$ AND $USe_x - Br_2$. Sevast'yanov, V. G.; Slovyanskikh, V. K.; Ellert, G. V. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim.; 16: No. 12, 3357-62(Dec 1971). (In Russian).

Equilibrium pressures were measured in the systems $US_x - Br_2$ and $USe_x - Br_2$. The reactions between Br_2 and the chalcogenide formed UBr_3 and chalcogen. An exception to this was the system $US_2 - Br_2$, in which the reaction products were UBr_4 and sulfur. All reaction equilibria were noticeably shifted to the right, and the equilibrium pressure was predominantly that of the chalcogen vapor. P–T curves for S_2Br_2 were used to estimate the amount of this compound in the gaseous phase at temperatures below 860°C. Measurements of dissociation pressures showed that some USe_2 and UTe_2 were formed and influenced the reaction (as opposed to the behavior of uranium sulfide). (tr-auth)

27954 COMPLEX FORMATION OF BERYLLIUM IN CHLORIDE–FLUORIDE MELTS. Lebedev, V. A.; Pyatkov, V. I.; Nichkov, I. F.; Raspopin, S. P. Zh. Neorg. Khim.; 16: No. 12, 3378-80(Dec 1971). (In Russian).

A molten salt cell was used to make emf measurements at 700°C with $Be/BeCl_2$ and U/UCl_3 electrodes with a molten mixture of KCl, NaF, and NaCl. The molar ratio of F/metal was varied from 0 to 6 for Be, and from 0 to 12 for U, and equilibrium constants were calculated for the formation of BeF_3^-, BeF_4^{2-}, and UF_4^-. (K.S.W.)

27955 THERMOGRAPHIC INVESTIGATION OF THE BINARY SALT SYSTEMS $PbCl_2$–$PuCl_3$ AND $ThCl_4$–$PuCl_3$. Vorobei, M. P.; Chernakov, A. E.; Skiba, O. V.; Desyatnik, V. N. Zh. Neorg. Khim.; 16: No. 12, 3388-9(Dec 1971). (In Russian).

Binary equilibrium diagrams were prepared by differential thermal analysis of the two molten salt systems $ThCl_4$–$PuCl_3$ and $PbCl_2$–$PuCl_3$ up to about 760°C. Eutectic melting points were observed at 620°C for the $ThCl_4$ system, (77% $ThCl_4$), and

at 476 and 502°C for the $PbCl_2$ system (85% and 60% $PbCl_2$, respectively). (K.S.W.)

27956 CYCLOOCTATETRAENYL COMPLEXES OF ACTINIDE ELEMENTS. PART I. THORIUM. Goffart, J.; Fuger, J.; Gilbert, B.; Kanellakopulos, B.; Duyckaerts, G. (Univ., Liege). Inorg. Nucl. Chem. Lett.; 8: No. 4, 403-12(Apr 1972).

The infrared, Raman, visible and x ray diffraction spectra of $(C_8H_8)_2Th$ are reported. The measurements are consistent with the idea of a sandwich compound with two organic rings of aromatic character. (auth)

27957 RECENT PROGRESS IN ACTINIDE RESEARCH. Lee, J. A. (Atomic Energy Research Establishment, Harwell, Eng.); Waldron, M. B. Contemp. Phys.; 13: No. 2, 113-33(Mar 1972).

The actinide elements are now sufficiently well understood to enable clearer analogies to be established between their properties and those of rare earth and transitional elements. Research in the past decade revealed systematic variations in bonding properties such as melting point, transport properties such as resistivity, and electronic properties such as specific heat. The earlier members of the series now are seen to have not only a transitional element type of behavior but one in which the 5f-electrons apparently make a substantial contribution to bonding. There are also important differences between the behavior of the heavier actinides and those expected from rare earth elements. The heavier actinides are now of considerable practical importance for such purposes as space research, industrial radiography, prospecting, and medical applications. The potential economic gains are likely to ensure a continuing research activity which will advance our basic understanding of these elements. (auth)

27958 β FORM OF AMERICIUM SESQUISULPHIDE. Damien, D.; Marcon, J. P.; Jove, J. (CEN, Fontenay-aux-Roses, France). Inorg. Nucl. Chem. Lett.; 8: No. 4, 317-20(Apr 1972).

The preparation of β-Am_2S_3 by thermal dissociation of americium disulphide and crystallographic characterization of the compound are discussed. (auth)

27959 LOSSES DURING STORAGE FROM RADIOACTIVE SOLUTIONS WITH STANDARDISED DISINTEGRATION RATE. Johnson, E. F.; Lowenthal, G. C. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Int. J. Appl. Radiat. Isotop.; 23: No. 4, 196-8(Apr 1972).

The problem of loss during storage from solutions having standardized disintegration rates is considered. Various types of vials, ampoules, and bottles together with coated and uncoated stoppers were investigated. The loss of moisture and absorption of solvent and activity onto uncoated rubber bungs are tabulated. Several methods for reducing vapor losses were tried but the most effective and simple was found to be the monitoring of weight changes which is described. The errors arising from these losses are discussed. (UK)

27960 INVESTIGATION OF THE COMPLEX FORMATION OF URANYL WITH AMINOALKYLPHOSPHONIC ACIDS. I. COMPLEX COMPOUNDS OF UO_2^{2+} WITH EDDP, EDDIP, AND DTPP. Razbitnaya, L. M. Sov. Radiochem. (Engl. Transl.); 13: No. 3, 420-5(May-Jun 1971).

Translated from Radiokhimiya; 13: No. 3, 405-11(May-Jun 1971).

The complex formation of uranyl with aminoalkylphosphonic acids in solution was studied by a spectrophotometric method. Solid complexonates were isolated and identified. (auth)

27961 INORGANIC REACTION MECHANISMS: I. THE THERMAL DECOMPOSITION OF METAL PEROXIDES USING THE DOUBLE-TAGGED ISOTOPE TRACER TECHNIQUE. II. THE KINETICS OF SUBSTITUTION OF MONO(TERPYRIDINE) NICKEL(II) WITH AMMONIA. Seyse, Robert John. Iowa City, Iowa; Univ. of Iowa (1971). 100p. University Microfilms Order No. 71-30,489.

Thesis.

The double-tagged isotope tracer technique is discussed in reference to the decomposition of metal peroxides. The results show that sodium peroxide octahydrate decomposes initially with almost no scrambling of oxygen isotope between peroxide ions. However, as decomposition proceeds, the amount of scrambling increases. The increase appears to be temperature dependent. Uranyl peroxide dihydrate and titanyl peroxide hydrate were also studied with this technique and found to give 20% and 30% initial scrambling. The amount of scrambling also increases as decomposition proceeds, but is not temperature dependent. Possible mechanisms are discussed. Theory and technique of the temperature-jump technique are discussed in terms of the general reaction

$$A + B \underset{k_r}{\overset{k_f}{\rightleftharpoons}} C.$$

Results of the substitution rate of mono(terpyridine)nickel(II) with ammonia at 25°C are reported as $2.0 \pm 0.4 \times 10^4\ M^{-1}\ sec^{-1}$. The relation of this rate to other substitution rates on mono(terpyridine)nickel(II) and other nickel(II) complexes is discussed in relationship to the currently accepted Eigen mechanism. (Diss. Abstr. Int., B)

Radioactive Waste Treatment

27962 (BLG-460, pp 9.11-13) RADIOACTIVE WASTE PROCESSING. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 1970.

In Annual scientific report, 1970.

RADIOACTIVE WASTE—processing in Belgium (M.C.G.)

27963 DECONTAMINATION OF RADIOACTIVE EFFLUENTS. Kieschnick, E. Sulzer Tech. Rev.; 53: No. 4, 227-35(1971).

Decontamination plants are used to reduce and remove radioactive substances from water-circulation systems and effluents. A general survey of the methods mainly used and the safety regulations to be complied with are discussed. (auth)

Radioisotope Production

27964 (BLG-460, pp 5.1-2) PRODUCTION AND APPLICATION OF RADIOISOTOPES. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 1970.

In Annual scientific report, 1970.

GAMMA SOURCES—uses in Belgium

RADIOISOTOPES—production in Belgium (M.C.G.)

27965 (BLG-460, pp 6.1-6) ACTINIUM PROGRAMME. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 1970.

In Annual scientific report, 1970.

ACTINIUM—production in Belgium

HOT CELLS—development for actinium handling

RADIUM—neutron reactions with, production of actinium by (M.C.G.)

27966 (FRNC-TH-145) SPECTROMETRIC INVESTIGATIONS OF VERY SMALL QUANTITIES OF RARE EARTHS FORMED IN NUCLEAR REACTIONS. A METHOD FOR SIMULTANEOUSLY IDENTIFYING THE A AND Z VALUES OF THESE ELEMENTS FROM THE DECOMPOSITION OF THEIR OXIDES. de Saint Simon, Michel (Paris Univ. (France)). 1971. 44p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A mass spectrometer was used to determine the relative cross sections of the $^{139}La(^{12}C,xn)^{151-x}Eu$ reactions. The quantities formed were of the order of 10^6 atoms. The thermal decomposition of the rare earths is as follows M_2O_3 (solid) → 2MO (gas) + O (gas) and MO (gas) → M (gas) + O (gas). Formulas were established relating the ratio of the intensities of the M^+ and $(MO)^+$ ions to the dissociation energy of the MO molecules, the atomic number, and the absolute temperature. The results of this investigation demonstrate that it is feasible to identify simultaneously the mass number and the atomic number of an unknown isotope in the 4f series. The mass number is indicated directly by the mass spectrometer, and the atomic number may be deduced from the variations in the $i(M^+)/i(MO^+)$ ratio with temperature. (France)

27967 (JINR-E6-6322) ON THE IDENTIFICATION OF ^{78}Rb ($T_{\frac{1}{2}}$ = 19 MIN). Arlt, R.; Beyer, G. J.; Herrmann, E.; Habenicht, W.; Tyrroff, H. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 6p. Dep. NTIS (U. S. Sales Only).

From the γ spectra due to the decay of ^{78}Rb it was concluded that the earlier reported 19-min activity belongs to the decay of the low-spin member of the ^{78}Rb isomeric pair. (auth)

27968 (JINR-P7-6300) ISOTOPE PRODUCTION IN BOMBARDING ^{238}U WITH ^{136}Xe IONS. Oganesyan, Yu. Ts.; Orlova, O. A.; Penionzhkevich, Yu. E.; Gavrilov, K. A.; Kim De En (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

Production cross sections were measured for ^{194}Au, ^{196}Au, ^{196m}Au, ^{198}Au, and ^{199}Au isotopes in bombarding ^{238}U with ^{136}Xe ions. The values obtained are from 0.12 to 0.32 mb. The results are compared with the data of calculations performed under the assumption about $^{174}146$ compound nucleus fission. The problem is discussed about the possible use of the fission mechanism in synthesis of heavier elements up to Z = 100 to 114. (auth)

27969 (JINR–P12-6234) STUDY OF VOLATILITY OF THALLIUM MICROQUANTITIES FROM PbF_2 CRYSTALS BOMBARDED WITH HIGH-ENERGY PROTONS. FAST GAS THERMOCHROMATOGRAPHIC METHOD OF SHORT-LIVED THALLIUM ISOTOPE PRODUCTION. Vandlik, Ya.; Vandlik, T.; Zaitseva, N. G.; Mate, Z.; Makhunka, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

The activation method was applied for studying the thermochromatographic behavior of volatile compounds of Tl microquantities in sublimating them from the bombarded PbF_2 crystals depending on the heating temperature, rate of the gas-carrier, sublimation time and the quantity of PbF_2. The results obtained are used in designing the express method of the radioactive Tl separation for production of the mono-isotope sources of short-lived Tl isotopes Tl($T_{\frac{1}{2}} \geq 1$ min) for the purposes of nuclear spectroscopy. (auth)

27970 (JINR–P14-6315) SOME SINGULARITIES OF THE PRODUCTION AND YIELD OF ^{18}F FROM TEFLON INDUCED BY NEUTRONS AND γ QUANTA. Kucher, A. M.; Penionzhkevich, Yu. E.; Flerov, N. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The production and yield of fluorine and its compounds from teflon, depending on different parameters (medium temperature, thickness of samples, etc.) and under the influence of small fluxes of neutrons and γ quanta $\{10^{10}$ [(freq./cm^2)/sec]$\}$, was studied. The results allow extrapolations to be made to determine the yields of various corrosion products from teflon. (auth)

27971 PREPARATION OF ^{90}Nb POSITRON SOURCE. Shiotani, Nobuhiro; Ambe, Shizuko; Okada, Takuya; Karasawa, Takashi (Inst. of Physical and Chemical Research, Wako, Japan). Jap. J. Appl. Phys.; 11: No. 3, 412-13(Mar 1972).

Factors to be considered in cyclotron production of radioisotopes are listed. The excitation function for the $^{90}Zr(d,2n)^{90}Nb$ reaction was measured from 12 to 22 MeV. The thick-target yield was 16 mCi/μA · h for 22-MeV deuterons. This activity was greater than that produced by the appropriate (p,n) and (p,2n) reactions at 15 MeV. The chemical procedures used to produce a ^{90}Nb positron source from the (d,2n) reaction are described. The source prepared gave a rate of about 200 cpm coincident γ rays for an angular correlation experiment. (1 figure, 1 table) (R.W.R.)

27972 EXTRACTION OF POLONIUM. Schulz, Wallace W. (Atlantic Richfield Hanford Co., Richland, Wash.). Solvent Extr. Rev.; 1: No. 2, 151-84(1971).

The current status of polonium solvent extraction chemistry is reviewed. The extractants tested to date, the aqueous media and polonium oxidation states employed, and 58 references are given. Alcohols, ethers, ketones, organic phosphorus compounds, amines, and chelating agents are evaluated as solvents. (M.C.G.)

Reactor Fuel Reprocessing

Refer also to abstracts 27796, 27829, 27836, 27844, 27859, and 30257.

27973 (ANL–7775) CHEMICAL ENGINEERING DIVISION ANNUAL REPORT, 1970. (Argonne National Lab., Ill.). Apr 1971. Contract W-31-109-eng-38. 161p. Dep. NTIS.

Progress is reported on research and development programs of Argonne's Chemical Engineering Division. Separate abstracts were prepared for five of the seven sections. The remaining sections consisted of a statement of a proposed study of nuclear safeguards undertaken to promote accountability and protection of nuclear materials, and progress is reported on an investigation of combustion of fossil fuels in fluidized beds as a means of reducing atmospheric pollutants. (D.H.M.)

For abstracts of individual sections see: 27974, 28535, 28609, 28610, and 30212.

27974 (ANL–7775, pp 15-36) FUEL CYCLE TECHNOLOGY. Webster, D. S.; Simmons, J. W. (Argonne National Lab., Ill.). Apr 1971.

In Chemical Engineering Division annual report, 1970.

Progress is reported on investigation of liquid-metal decladding as a head-end process for LMFBR fuel, laboratory and pilot-scale work on the conversion of uranium and plutonium nitrates to oxides, development work on a centrifugal contactor for aqueous processing of LMFBR fuels, and studies of analytical procedures adaptable to on-line use in the fabrication of LMFBR fuels. (D.H.M.)

27975 (ANL–7871) CHEMICAL ENGINEERING DIVISION FUEL CYCLE TECHNOLOGY QUARTERLY REPORT, JULY–SEPTEMBER 1971. Webster, D. S.; Jonke, A. A.; Bernstein, G. J.; Levitz, N. M.; Pierce, R. D.; Steindler, M. J.; Vogel, R. C. (Argonne National Lab., Ill.). Dec 1971. Contract W-31-109-eng-38. 55p. Dep. NTIS.

Work was carried out in the following areas: (1) further development of a head-end process for removing stainless steel cladding in a zinc bath consisted of study of materials for retort crucibles, reduction of unirradiated uranium oxide and plutonium oxide, and modification of the flowsheet for the head-end process; (2) shakedown of the pilot-scale reactor for production of UO_2-PuO_2 by denitration of uranyl nitrate and plutonium nitrate in nitric acid; (3) further laboratory-scale work to determine the effects of bulk density and particle size on x-ray fluorescence signals in determining Pu/U ratios of oxide fuels; (4) continued investigation of the effects of equipment modifications and operating conditions on the separating capacity of a centrifugal contactor for the plutonium isolation steps in the solvent extraction of LMFBR fuels; and (5) study of the effect on reduction rates of process parameters in the operation of an electrolytic cell for the reduction of plutonium in the Purex process. (auth)

27976 (ANL-Trans–912) STUDY OF AQUEOUS PROCESSING METHOD: LABORATORY. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translation of Section 7, pp 207-39 of report CEA-N-1479. 32p. Dep. NTIS.

Use of tridodecylamine for fuel and irradiated target processing, aromatic diluents for tridodecylamine, radiolysis research, oxide fuel dissolution, and testing of industrial centrifugal extractors are discussed. For abstract of the entire report, CEA-N-1479, see 26: 14703. (M.C.G.)

27977 (BARC–544) NEW METHOD FOR THE ESTIMATION OF DIBUTYL PHOSPHATE (DBP) AND A STUDY OF THE PARAMETERS INVOLVED IN THE EXTRACTION OF MOLECULAR IODINE BY TRI-n-BUTYL PHOSPHATE (TBP). Shanker, Ramendra; Venkateswarlu, K. S. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 17p. Dep. NTIS (U. S. Sales Only).

A method was developed for estimation of dibutyl phosphate or a mixture of dibutyl phosphate and monobutyl phosphate. It is based on the decolorization of a lanthanum–Xylenol Orange complex by dibutyl phosphate at pH 5. It is applicable even in the presence of free nitric acid, which is neutralized in adjusting the system to this pH. The effects of iodine sensitization of tributyl phosphate degradation and the parameters involved in the extraction of molecular iodine by tributyl phosphate were investigated. (auth)

27978 (RT/CHI–(71)15) OXIDATION-REDUCTION REACTIONS BETWEEN NEPTUNIUM VALENCE STATES AS AFFECTED BY TERTIARY AMINES USED AS EXTRACTANTS. Basili, N.; Delle Site, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 25 Oct 1971. 23p. (In Italian). Dep. NTIS (U. S. Sales Only).

The behavior of neptunium in extraction by tertiary amines is complicated because of redox reactions that take place principally in the organic phase. The IV, V, and VI valence states of neptunium are involved in these reactions, as demonstrated by spectrophotometric analysis of both phases and by determining the distribution coefficients of the element in these different oxidation states. The results indicate that, irrespective of the nature of the ion present in the phases before their contact, the system shows a tendency to establish an equilibrium: $Np(IV)_{org} \rightleftharpoons Np(V)_{acq}$. The presence of nitrous acid accelerates the reduction of Np(VI) to Np(V) and increases its back extraction. (auth)

27979 (UJV–2736-Ch) NEPTUNIUM FLUORIDE AND THE BEHAVIOR OF NEPTUNIUM DURING FLUORIDE REGENERATION OF NUCLEAR FUEL. Vanka, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1971. 32p. (In Czech). Dep. NTIS (U. S. Sales Only).

Data published to September 1971 are compiled. NpF_6 is a stable compound, physical properties of which are very similar to those of UF_6 and PuF_6. Though the reactivity of NpF_6 is intermediate between the reactivities of the two hexafluorides, there are several potential ways of separating Np from a mixture of actinide hexafluorides. Sorption on sodium fluoride or successive selective reduction of PuF_6 and NpF_6 are the most promising methods of neptunium isolation. (auth)

27980 APPLICATION OF THE PROPERTIES OF FLUORIDES IN NUCLEAR FUEL CYCLES. Bourgeois, M. (Centre d'Etudes Nucleaires, Aux-Roses, France); Cochet-Muchy, B. Bull. Inform. Sci. Tech. (Paris); No. 161, 41-50(Jul-Aug 1971). (In French).

Large-scale production of uranium hexafluoride has greatly contributed to the development of uranium separation and purification processes based on the properties of fluorides. Various ap-

plications of the main separation techniques described can be found in the nuclear fuel cycle: production of pure uranium hexafluoride from ore concentrates or reprocessed spent fuels, recovery of fissile materials from fuel manufacture wastes, and irradiated fuel reprocessing. The reprocessing methods using volatilization being studied at Fontenay-aux-Roses are briefly reviewed. (France)

27981 INTERACTIONS OF ACIDIC ORGANOPHOSPHORUS EXTRACTANTS IN THE ORGANIC PHASE. Kolarik, Z. (Kernforschungszentrum, Karlsruhe, Ger.). Solvent Extr. Rev.; 1: No. 1, 1-62(1971).

Data are presented and reviewed on reactions of acidic organophosphorus extractants. Regularities are pointed out which make it possible to understand and perhaps predict the behavior of acidic organophosphates in two-phase systems. Topics covered include: types of reactions, equilibria and determination of equilibrium constants, effects of the organophosphate structure on partition equilibria and self-association equilibria, thermodynamics of the systems, molecular complex formation equilibria, and reactions in the organic phase with water and mineral acids. (81 references) (M.C.G.)

27982 KINETICS OF METAL EXTRACTION BY ORGANOPHOSPHORUS ACIDS. Coleman, C. F.; Roddy, J. W. (Oak Ridge National Lab., Tenn.). Solvent Extr. Rev.; 1: No. 1, 63-91(1971).

Kinetic studies of extractions by organophosphorus acids were made of U, Fe, Be, Cu, and Co. Extractions using DEHPA were emphasized. Related studies on extraction chromatography and aqueous solubility of extractants are discussed. (58 references) (M.C.G.)

27983 SOLVENT EXTRACTION OF PROTACTINIUM. Guillaumont, R.; Miranda, C. (Institut de Physique Nucleaire, Orsay, France). Solvent Extr. Rev.; 1: No. 1, 105-49(1971).

Data published up to 1970 on solvent extraction of protactinium are summarized. Extraction with chelating agents (such as β-diketones), acidic organophosphorus compounds, and other solvents by compound formation is discussed. The extraction of protactinium by solvation using phosphorus-bonded oxygen donor extractants and carbon-bonded oxygen donor extractants is also considered along with protactinium extraction by ion pair formation using amines. Synergism in the solvent extraction of protactinium and extraction of protactinium from molten salts are also discussed. (150 references) (M.C.G.)

27984 MIXING EQUIPMENT IN LIQUID–LIQUID EXTRACTION. Oldshue, J. Y. (Mixing Equipment Co., Inc., Rochester, N. Y.). Solvent Extr. Rev.; 1: No. 2, 185-213(1971).

The Scheibel column, Oldshue–Rushton column, and countercurrent mixer-settlers are considered. For single-stage contacting, prediction of the dispersed phase, dispersion formation, drop size, interfacial area, actual plant operations, and mass transfer are considered. In continuous countercurrent extractors, holdup, axial mixing, performance data, and stage construction are discussed. (227 references) (M.C.G.)

27985 MODEL EXPERIMENTS ON CHEMICAL REPROCESSING OF NUCLEAR FUELS BY A CHLORIDE VOLATILIZATION PROCESS. PART 2. BEHAVIOUR OF THE FISSION PRODUCTS RUTHENIUM, RHODIUM, PALLADIUM DURING VOLATILIZATION OF LOW URANIUM CHLORIDES BY CHLORINATION. Reinhard, G.; Stahlberg, R.; Edelmann, B. U. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 14: No. 11, 356-60(Nov 1971). (In German).

Chlorination of appropriate model mixtures under various conditions of reaction showed that with strict exclusion of oxygen and avoidance of contact between reactive and oxidic material a decontamination factor of about $D_{Ru} = 10^3$ for ruthenium may be obtained. The corresponding value for palladium is lower by one order of magnitude because of the formation of a compound between $PdCl_2$ and UCl_4. For further isolation of the fission products ruthenium and palladium an additional purification of the sublimed uranium chlorides has therefore to be provided. More favorable were the results with respect to depletion of rhodium, the decontamination factor of which turned out to be $D_{Rh} \approx 10^3$ after a single-step process. (auth)

ENGINEERING

Energy Conversion

Refer also to abstract 28298.

27986 (ALO–2510–1) SILICON GERMANIUM THERMOELECTRIC MATERIALS AND MODULE DEVELOPMENT PROGRAM. 1st Quarterly Report, December 20, 1967–March 31, 1968. (RCA, Harrison, N. J.). Contract AT(29-2)-2510. 85p. Dep. NTIS.

Declassified 2 Nov 1971.

Research and development progress is reported on SiGe thermoelectric materials technology, Air-Vac Module technology, and cascaded converter technology. (J.R.D.)

27987 (BMI–1786) DEVELOPMENT OF SEGMENTED THERMOELECTRIC MODULES. Phase 2 Summary Report. Mueller, John J. (Battelle Memorial Inst., Columbus, Ohio). 15 Dec 1966. Contract W-7405-eng-92. 86p. Dep. NTIS.

Declassified 2 Nov 1971.

An oriented form of BiXTe which was superior in performance to the previously used powder product was incorporated into the segmented elements. Emphasis was placed on the investigation of p-type PbTe materials and junctions. Electrical resistivity and Seebeck coefficient measurements showed that considerable variability in material properties existed among purchased batches of PbTe. Adsorbed gases were identified as the cause of severe cracking which was associated with material swelling; a powder pretreatment process was developed to eliminate this reaction. Various junction designs and fabrication procedures aimed at reducing fragility, junction resistance, and power degradation were evaluated. Measurements of contact resistivity at design operating temperatures were performed to support the selection of junction designs. These data were also used in analyses to predict thermoelectric energy conversion. With the use of operating-temperature resistance values, good correlation was found between the computed values and measured values of efficiency. The work was summarized in a trade-off and comparison which included the effect of material-properties variation and contact-resistivity variation on thermoelectric-energy conversion efficiency. Further evaluations included extended life testing of thermoelectric couples which were fabricated on the basis of most promising designs. Fabrication techniques for the module were investigated in order to develop practical fabrication methods for modules of stable and high-efficiency performance. Feed-through designs, methods of can closure, and methods for reducing thermal impedance by utilizing printed-circuit techniques were examined. (auth)

27988 (N–72–12605) PARAMETRIC TESTING OF AN EXTERNALLY CONFIGURED THERMIONIC CONVERTER. Shimada, K.; Rouklove, P. (Jet Propulsion Lab., Pasadena, Calif.). 1 Nov 1971. Contract NAS7-100. 30p. (NASA-CR–124576; JPL-TM–33-504). NTIS.

A 25.4-cm long externally configured converter was performance tested by electrically heating the emitter to simulate reactor thermal power input. The measured maximum output power was limited by the maximum input power available from the electric rf induction heater. With maximum heater input power, the converter electric output was 178 W (1.95 W/sq cm) at an emitter temperature of 1946°K. This electric output power was smaller than expected. A reactor-core-length (25.4-cm long) cylindrical thermionic converter power and maintaining the emitter-to-collector gap without shorting are of major importance to the feasibility of a 25.4-cm-long reactor fuel element. The emitter of the converter is located externally to the collector to increase the fuel-volume fraction and to allow redundant collector cooling in a reactor configuration. (auth) (STAR)

27989 ATOMIC ENERGY RESEARCH ESTABLISHMENT MINIATURE NUCLEAR BATTERY. Penn, A. W.; Brown, M. H.; Myatt, J.; Poole, M. J. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Technol.; 14: No. 1, 89-96(Apr 1972).

The design, construction, and details of the electrical output characteristics of the plutonium-powered battery are described. The influence of the isotopic fuel purity on the nuclear radiation is discussed, and relative dose rates are presented. The safety testing of both the capsule and the battery are also described. (auth)

Facilities and Equipment

Refer also to abstract 28528.

27990 (DSR–73047-1) DRY COOLING TOWERS FOR COOLING PLANTS. Andeen, Bruce R.; Glicksman, Leon R. (Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering). 1 Feb 1972. 125p.

For Consolidated Edison Co. of New York, Inc., New York.

A literature survey of capital costs of dry cooling towers was performed. Heat exchanger surfaces were compared in terms of heat transfer coefficient and friction power per unit heat transfer area. A computer program was developed to design the heat exchanger configuration resulting in the lowest total operating cost per kilowatt-hour for a dry cooling tower. Input data includes fuel costs, cost of lost capacity per kilowatt-hour, maintenance and interest rates, turbine heat rate versus back pressure, boiler costs, friction, and heat transfer coefficients for the heat transfer surface. Studies of periodic exchangers showed that liquid or loose periodic material is impractical. However, rigid periodic surfaces are promising if liquid carryover and subsequent air side evaporation can be reduced, perhaps by using a non-wetting surface. Carryover and evaporation tests of a rigid Teflon-coated periodic surface are underway. If a method to remove large drops from the periodic surface can be perfected, its evaporation rate will be an order of magnitude less than the wet tower's, while the costs of the two should be competitive. A packed bed heat exchanger consists of small balls attached to the outside of tubes carrying hot liquid. The balls act as fins; air blown through the balls cools the liquid. Several methods of joining balls were tested to find the method which minimizes heat transfer resistance from ball to ball. Zinc coated steel balls and epoxy coated aluminum balls have shown promising performance in simple configurations. The first assemblies made with these techniques exhibited considerable blockage of the air passages between the balls. (auth)

27991 (HASL–249, pp I,12-17) SIMPLE GANG-TUMBLERS FOR MIXING AND EXTRACTING OPERATIONS IN THE ANALYSES OF ENVIRONMENTAL SAMPLES FOR TRACES OF CESIUM. Folsom, T. R. (Scripps Institution of Oceanography, La Jolla, Calif. Soledad Lab.). 1 Apr 1972.

In Fallout program quarterly summary report, December 1, 1971–March 1, 1972.

The design and operation of a simple multiple-tube tumbling mechanism for mixing, concentrating, and extracting trace amounts of ^{133}Cs from relatively large volumes of seawater are described. (L.C.L.)

27992 (LA–4547) PRELIMINARY STUDY OF THE NUCLEAR SUBTERRENE. Robinson, E. S.; Potter, R. M.; McInteer, B. B.; Rowley, J. C.; Armstrong, D. E.; Mills, R. L. (Los Alamos Scientific Lab., N. Mex.). Apr 1971. Contract W-7405-eng-36. 62p. Dep. NTIS.

The rock-melting drill was invented at Los Alamos Scientific Laboratory in 1960. Electrically heated, laboratory-scale drills were subsequently shown to penetrate igneous rocks at usefully high rates, with moderate power consumptions. The development of compact nuclear reactors and of heat pipes now makes possible the extension of this technology to much larger melting penetrators, potentially capable of producing holes up to several m in dia and several tens of km long or deep. Development of a rapid, versatile, economical method of boring large, long shafts and tunnels offers solutions to many of man's most urgent ecological, scientific, raw-materials, and energy-supply problems. A melting method appears to be the most promising and flexible means of producing such holes. It is relatively insensitive to the composition, hardness, structure, and temperature of the rock, and offers the possibilities of producing self-supporting, glass-lined holes in almost any formation and (using a technique called lithofracturing) of eliminating the debris-removal problem by forcing molten rock into cracks created in the bore wall. Large rock-melting penetrators, called Electric Subterrenes or Nuclear Subterrenes according to the energy source used, are discussed together with problems anticipated in their development. It is concluded that this development is within the grasp of present technology. (auth)

27993 (ORNL–TM–3740) QUALITY ASSURANCE PLAN FOR THE LARGE-SCALE PROCUREMENT OF TEMPERATURE SENSORS. Herskovitz, M. B. (Oak Ridge National Lab., Tenn.). 1 Mar 1972. 18p. Dep. NTIS.

Supersedes CF–71-12-37.

A quality assurance program plan was prepared for large-scale procurement of thermocouple bulk material and assemblies. This plan meets the requirements of AEC-RDT Standards C 7-6 and F 2-4T and describes the functions and responsibilities of each

participant, i.e., the seller, the user, and ORNL personnel in specifying, procuring, storing, assembling, testing, and shipping bulk materials, assemblies, and samples. This plan assures users that they will obtain thermocouples that meet the requirements specified by them. (auth)

27994 STRUCTURAL TESTING FACILITIES FOR SODIUM MACHINERY AND EQUIPMENT. Yoshitoshi, Shoji (Kawasaki Heavy Industries, Ltd., Kobe, Japan). FAPIG (Tokyo); No. 61, 20-4(May 1971). (In Japanese).

As a part of the project for the development of fast breeder reactors, many facilities for development and testing of sodium techniques have been constructed in the engineering center at Oarai. Test loops may be divided into three groups such as a material testing loop, a loop for development of the sodium techniques, and a loop for hot steel testing. The material testing loop has one mother loop and four daughter loops. The mother loop controls purity of sodium and supplies each daughter loop with purified sodium. The daughter loops comprise a mass transfer loop, a fretting corrosion testing loop, and two types of creep testing loops. The loop for development of sodium techniques was established for endurance test and heat-resistance test of small-sized machines and parts, and for development test of measuring instruments for sodium. The hot steel test loop has the same construction as the mass transfer loop, but in the hot steel loop, activated materials are used as tracers in order to analyze mass transfer mechanisms. After construction, deterioration of insulation in preheaters of all the loops occurred. It was found that the deterioration of insulation was not caused by the decrease of insulation of heater sheaths, but by corrosion rupture of the heater sheaths. Cause of the corrosion rupture was not clear, however, since the heater sheaths were rebuilt without using heat conductive cement and binder, no accident has occurred. (Japan)

27995 CONTROLLED ATMOSPHERE CHAMBER FOR TREATING PRODUCTS WITH IONIZING RADIATION. Coleman, George E. (to PPG Industries, Inc.). U. S. Patent 3,654,459. 4 Apr 1972. Filed 18 Aug 1969.

Apparatus is described which permits treatment of products with ionizing radiation in a controlled atmosphere comprises a chamber having inlet and outlet openings for the passage of a product to be treated, a radiation-permeable window in one surface, and at least one gas reservoir within the chamber separated by a foraminous panel. Gas is introduced into the reservoir, passes through the foraminous panel and over and around the path of travel of the workpiece to be treated. (Official Gazette)

27996 FACILITY FOR IODINE AND METHYL IODIDE RADIOLYSIS TESTS (14 May 1971) (Engineering Materials). (Savannah River Operations Office (AEC), Aiken, S. C.). (CAPE-2196).

A test-filter assembly permits testing of all confinement system components (carbon bed, HEPA filter media, moisture-separator media, gaskets, adhesives, etc.) simultaneously in an intense gamma radiation field under postulated accident conditions. Flow areas of components are scaled to obtain face velocities equivalent to full size components in the confinement system. The assembly can be positioned in the gamma field so that any single component is in the highest flux zone, while other components receive a lesser exposure. The assembly contains six independent modules. Each module has an outer and inner wall. Cold or heated water can flow through the annular space between the walls to heat or cool each module independently. The annular space is seal welded from the inside of the module. The modules are sealed to each other with Neoprene O-rings or fiberglass gaskets, allowing water cooling or heating without risking leakage of water into the process-gas stream. A chamber is provided to trap entrained water which can be removed from the process gas stream by the moisture separator or particulate filter during a stream-air test. Temperature of the process gas stream is monitored at four locations. Temperature of the effluent cooling water from each module can also be monitored. A ^{60}Co source consisting of $\sim 3 \times 10^6$ Ci of ^{60}Co in 28 slugs is arranged in a ring around the base of a 10 in. dia air-filled Al access tube. The source is under 24 ft of water. The gamma dose rate is $\sim 2 \times 10^7$ rads/hr. (For details see TID-4100 Suppl 70) (see also 26: 6360) (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 27862, 27990, 28291, 28583, 30263, 30474, and 30475.

27997 (JUL-815-RB) FLOW DYNAMICS AND AEROACOUSTIC PHENOMENA IN CYLINDRICAL LATTICES. Heinecke, Ernst (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorbauelemente). Dec 1971. 78p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Universitaet, Berlin (West Germany).

Fluid flow through a series of cylindrical lattices was studied to determine the hydrodynamic, aerodynamic, and acoustic behavior. The cylinders were arranged in a checkerboard fashion. Distances between cylinder axes were varied within a wide range. The maximum number of successive series in the flow direction was ten. For Reynolds Numbers below 10^3, the flow pattern of water was studied visually. Vortex formation was caused by coupling effects on adjacent cylinders. Vortex formation was predominantly laminar. For Reynolds numbers in the range from 10^4 to 10^5 and with air flow through the cylinder lattice, the flow became increasingly turbulent. Methods for calculating the flow patterns were developed. If the eigenfrequency of the flow channel containing the cylinder was known, a boundary could be established below which the triggering of standing acoustic waves became improbable. (H.B.G.)

27998 (Y-1741) HEAT TRANSFER STUDY FOR A QUASI-ISOSTATIC HOT PRESSING PROCESS. Wayland, H. P. Jr. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 11 Apr 1972. Contract W-7405-eng-26. 83p. Dep. NTIS.

Heat transfer studies of quasi-isostatic hot pressing processes employing evacuated magnesium oxide and zirconium dioxide sand mediums were conducted using an advanced heat conduction computer program named HEATING 3. Experimental data was used to determine the variation of the effective thermal conductivity of compressed magnesium oxide sand with temperature. The effects of insulating the hot zone of the system with zirconium dioxide in place of magnesium oxide were determined. The zirconium dioxide reduced the input power requirements for a given steady state temperature by a factor of five to six and slowed the dynamic response of the system to power changes by a similar factor. The zirconium dioxide also reduced the magnitude of thermal gradients in the load being processed by a factor of approximately three. When the system heating coil was contoured to reduce end heat loss effects, load temperature gradients were further reduced under steady state conditions. However, during transient periods following abrupt power cutoff, the temperature gradients in contoured-coil systems were only slightly smaller than those in cylindrical-coil systems. Frequency response analysis showed the system dynamics to be predominantly first order lag. (auth)

27999 DYNAMIC ANALYSIS OF PLANT CHARACTERISTICS ON A TEST ESTABLISHMENT OF A 50 MW SODIUM-HEATED STEAM GENERATOR. Takitani, Koichi; Sasaki, Takashi (Kawasaki Heavy Industries, Ltd., Kobe, Japan). FAPIG (Tokyo); No. 61, 8-13(May 1971). (In Japanese).

As a part in the development project on sodium-cooled fast breeder reactors, a 50 megawatt sodium-heated steam generator is being constructed. Dynamic analysis of plant characteristics was performed in order to safely operate this steam generator in the prescribed performance range. This steam generator has three primary sodium loops, a secondary sodium loop, and a water-steam loop. Operating conditions which must be considered are design conditions and transients. Simulation of this system in the transient condition is analyzed by evaluating open loop characteristics of each system and by relating each controller, system, and equipment. Using this method, a complete model was constructed by adopting most suitable control method and control constants. Model results confirmed that the transient operation test can be performed using this system as related to a specific design. Stress analysis of each section was also made and it was confirmed that this steam generator can be operated safely. (Japan)

28000 MEASUREMENT OF LOCAL MASS TRANSFER COEFFICIENTS FOR FLOW PAST SOLID BODIES WITH THE AID OF RADIOISOTOPES. Glietenberg, Helmut; Blenke, Heinz (Univ., Stuttgart). Chem.-Ing.-Tech.; 44: No. 5, 319-25(Mar 1972). (In German).

A method is described for the measurement of mass transfer at bodies in a forced stream of air. Sulfur dioxide labeled with ^{35}S was added to a stream of air in a wind tunnel. A circular cylinder served as test body and was covered with paper wetted with a reaction solution; the SO_2 was absorbed and bound by the reaction solution at the surface of the paper. The distribution of radioactivity on the paper was determined photometrically from autoradiographs. The concentration of the $^{35}SO_2$ in the wind tunnel was measured by a liquid-scintillation method. An error of $\pm 4.5\%$ was calculated for this method of determining local mass transfer coefficients. (auth)

Materials Testing

Refer also to abstracts 27994, 28028, and 28594.

28001 (MTB-71) PROGRAMMED TEST METHOD OF HEAVY THICKNESS STEEL PLATES FOR NUCLEAR VESSELS. Susukida, Hiroshi; Ando, Tomozumi; Hibaru, Yoshinao (Mitsubishi Heavy Industries Ltd., Tokyo (Japan)). Apr 1971. 8p. NTIS (U. S. Sales Only).

A programmed test method was developed which is capable of verifying the mechanical properties of heavy thickness steel plates for nuclear vessels by using small specimens which are simulated to the cooling curves from austenitized temperature of vessel segments by a specially designed heating and cooling apparatus. This test method can be applied to production in place of the conventional vessel test method or the 3T test method which requires a large quantity of testing materials. (auth) (Japan)

28002 (ORNL-TM-3658) STRESS INDICES AND FLEXIBILITY FACTORS FOR MOMENT LOADINGS ON ELBOWS AND CURVED PIPE. Dodge, W. G.; Moore, S. E. (Oak Ridge National Lab., Tenn.). Mar 1972. Contract W-7405-eng-26. 59p. Dep. NTIS.

Flexibility factors and stress indices for elbows and curved pipe loaded with an arbitrary combination of in-plane, out-of-plane, and torsional bending moments are developed for use with the simplified analyses procedures of present-day design codes and standards. An existing analytical method was modified for use in calculating these factors, the equations were programmed for the IBM-360 computer, and computed results were compared with experimental data to establish the adequacy of the modified method. Parametric studies were then performed to obtain desired information. The results are presented in both tabular and graphical form. Approximate equations of best fit, developed from the tabulated values, are presented in a form which can be used directly in the codes and standards. The equations are more conservative than others in current use. However, experimental and analytical studies now in progress may indicate further modifications in the stress indices and flexibility factors for elbows. (auth)

28003 NEUTRON RADIOGRAPHY AND POSSIBILITIES OF ITS APPLICATIONS IN CZECHOSLOVAKIA. Hrdlicka, Z. (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ.; 18: No. 4, 109-16(Apr 1972). (In Czech).

A general introduction to neutron radiography is presented and the principal features of work already done are reviewed. Current intentions and possibilities concerning future development in Czechoslovakia of these techniques are outlined. (auth)

28004 HOLOGRAPHIC INTERFEROMETRY IN MATERIALS TESTING. Vest, Charles M. (Univ. of Michigan, Ann Arbor). Int. J. Nondestruct. Test.; 3: No. 4, 351-74(Mar 1972).

The theoretical basis and practical realization of optical wavefront reconstruction (holography) are described. Holographic interferometry is the interferometric comparison of two wavefronts, at least one of which is obtained by reconstructing a hologram. This type of interferometry can be employed to generate a fringe pattern which is indicative of change occurring in the configuration of a test object. Specifically, the field of surface displacement of a three-dimensional diffusely-reflecting object can be determined; or changes in thickness or in refractive index of a transparent object can be visualized. The method can also be extended to measure local amplitude and relative phase of a vibrating surface. Holographic interferometry can be applied to problems of material testing and experimental stress analysis. Its key features are high sensitivity and applicability to testing of objects of complex shape and surface structure. Testing applications fall into two broad categories: the quantitative determination of object displacement under static or vibratory load, and the detection of material defects by examination of local perturbation in object distortion when subjected to loading. Experimental requirements, accuracy, and sensitivity of holographic interferometry are discussed. Representative applications to materials testing problems are presented. Emphasis is placed on the detection of surface or near-surface defects such as early detection of delayed cracking, fatigue damage, and bond imperfections. Other applications are considered briefly, and possible extensions of the method and means of reducing the severity of experimental constraints are described. (auth)

28005 REMOTE-CONTROLLED ULTRASONIC TESTING OF ACTIVATED REACTOR PRESSURE VESSELS. Meyer, H. J. (Maschinenfabrik Augsburg-Nuernberg AG, Nuremberg). Allianz. Ber. Betriebstech. Schadenverhuetung; No. 15, 21-8(1971). (In German).

In tandem ultrasonic testing, the transmitter and receiver heads operate in conjunction with one another. This has the advantage that the ultrasonic transit times are improved and that each testing head tandem has only one constant depth to cover, thus rendering it possible to operate with unvarying sensitivity. In remote-controlled ultrasonic testing of activated reactor pressure vessels, various designs for manipulating equipment evolve from the different types of existing reactor construction. The spider manipulator consists of a central mast fitted with a spider-shaped arm at the lower end for testing vessel walling and spherical bottoms and a radial arm for strut testing. The external control testing of reactor pressure vessels, on the other hand, is carried out by means of a guide-rail device. In nuclear power plants already in operation, the refueling platform has also been used in the fitting of special inspection testing manipulators. (INIS)

28006 USE OF FLUORESCENT X-RAY RADIATION FOR THE MEASUREMENT OF THIN COATING LAYERS. Seda, J. (Karlova Univ., Prague). Radioisotopy; 13: No. 2, 339-59 (1972). (In Czech).

In recent years an increasing use is being made of the fluorescent x-ray radiation induced by radionuclides, namely in nondestructive sample analysis of earth, ores, and other materials. In the technology of coating of base materials with thin layers of protective material, methods for the measurement of the thickness of these layers are necessary. In addition to known methods, as for example the beta-particle backscatter measurement, the fluorescent x-ray radiation method of measurement of coating layer thickness is now available, using the detection of secondary radiation induced in the base material, where the thickness of the coating layer is determined by the absorption of the secondary radiation, or the detection of secondary radiation induced in the coating layer itself. Measurement of thin varnish and tin layers on steel, by induction and detection of secondary radiation is examined. The choice of a suitable detector of low-energy secondary radiation is of primary importance in industrial application of this method, as well as the design of a simple and reliable electronic evaluation device. The choice of the radionuclide with a satisfactory primary radiation energy is made with respect to the atomic number of the excited material. In addition to a short theoretical analysis of the method, measurement results are given. (auth)

28007 INVESTIGATION OF WEAR AND CRACKS IN A MODIFIED ALKALINE POLYAMIDE BY MEANS OF RADIONUCLIDES. Krejci, M.; Mysak, F. (Statni Vyzkumny Ustav Materialu, Prague). Radioisotopy; 13: No. 2, 265-73(1972). (In Czech).

A method was developed for crack detection in polyamide by autoradiography. The sample activation was performed using a 1% H_2SO_4 (^{35}S) solution. The autoradiograms were prepared on nuclear emulsions ORWO AF 3 and ORWO K 106. In further experiments the wear of polyamide disks on a modified ŠKODA-Savin machine was investigated. The residue activity of the disks was measured using a GM-tube and the wear was evaluated from the calibration curve obtained by processing of standards. The test disks and standards were activated simultaneously using a H_2SO_4 (^{35}S) solution. (auth)

28008 RADIOGRAPHY OF METAL MATRIX COMPOSITES. Martin, George; Moore, J. F.; Tsang, S. (North American Rockwell Corp., Los Angeles). Mater. Eval.; 30: No. 4, 78-82; 83-6(Apr 1972).

A comprehensive survey was made of the applicability of a wide variety of radiographic methods and variables to metal matrix composites. It was shown that comparatively simple rules for the optimization radiographic parameters allow the definition of filament details down to the resolution of single filament strands in even multilayer composites. For resolution, the type R film was found to be superior to the more rapid type M film, which, however, is adequate for most purposes. For highest resolutions, microfilms should be used. Densitometry and particularly microdensitometry is applicable to composites with only a few filament layers and may allow determination of width of diffusion layers, relative local spacings. Dynamic radiography of composites under loads requires, in the case of boron or silicon carbide filaments, the availability of high resolution vidicon tubes, but is quite feasible. Quantitative measurements of absorption or scatter factors are relatively more complex procedures. Results can be obtained, but, because of the influence of a number of factors, such as local filament density variations, existence of surface and interface layers and local thickness variations seem promising only on a comparative basis for sections manufactured by similar methods under similar conditions. A number of methods and approaches were worked out and analyzed. (auth)

28009 ELECTROTHERMAL NONDESTRUCTIVE TESTING OF METAL STRUCTURES. McCullough, L. D.; Green, D. R. (Battelle-Northwest, Richland, Wash.). Mater. Eval.; 30: No. 4, 87-91(Apr 1972).

The electrothermal method is a nondestructive testing technique

applicable to metal parts and structures. Welds may be tested for voids, cracks and slag inclusions. Relatively complex machined or cast parts may be tested. Moderate surface waviness does not affect the test. To apply the electrothermal method, the specimen is subjected to an electrical current pulse to develop a surface temperature distribution that is indicative of internal defects. This distribution is mapped by infrared or other thermal imaging techniques. Defect indications are superimposed upon the normal temperature profile of a good part or weld, but can usually be easily separated from the normal profile. Laboratory tests have been made locating voids in welded test bars and weld inclusions in 2 in. thick steel plate. Voids and cracks have been detected in turbine blades. (auth)

Nuclear Explosions

Refer also to abstracts 28078 and 28103.

28010 (CU-3134-1) COMPREHENSIVE STUDY OF THE SEISMOTECTONICS OF THE ALEUTIAN ARC. Annual Progress Report, May 15, 1971–May 14, 1972. (Columbia Univ., Palisades, N. Y. Lamont-Doherty Geological Observatory). Feb 1972. Contract AT(11-1)-3134. 21p. Dep. NTIS.

The field program conducted during the period was directed mostly to improving existing semipermanent seismic stations at Amchitka, Dutch Harbor and St. Paul, and installation of stations at Akutan Island, and Sand Point. An abstract summarizing research on earthquakes in the Aleutians is included. Abstracts summarizing research work to be reported and abstracts summarizing papers in preparation are also included. (J.R.D.)

28011 (EERO-TR-40) PREDICTION OF GROUND-SHOCK-INDUCED AIRBLAST OVERPRESSURES FOR SUBSURFACE EXPLOSIONS FROM PEAK VERTICAL SPALL VELOCITY. Snell, Charles M.; Oltmans, Dennis L. (Army Engineer Explosive Excavation Research Office, Livermore, Calif.). Nov 1971. 65p. Dep. NTIS.

A technique is presented for the prediction of ground-shock-induced airblast overpressures resulting from the subsurface detonation of nuclear and chemical explosives. The technique is based on a theory and physical model which correlates ground-shock-induced airblast overpressures with the vertical velocity of the rising mound above the detonation point. The derivation of the theory is reviewed in detail and the model's predictions are compared with airblast overpressure values measured during almost a score of large-yield chemical and nuclear detonations. Appendixes provide supplementary information on the correlation between vertical surface velocities and induced overpressures, extend the theory to five- and seven-charge row detonations, and apply the theory to contained and mounding detonations and to detonations in a noncompetent saturated medium overlain with water. (auth)

28012 (SC-DC-714471) CANNIKIN CLOSE-IN GROUND MOTION AND THE MOTION INDUCED BY MILROW. Perret, William R. (Sandia Labs., Albuquerque, N. Mex.). [nd]. 18p. (CONF-720311-1). Dep. NTIS.

From sixty-seventh annual meeting of the Seismological Society of America; Honolulu, HI. (30 Mar 1972).

Motion of the ground induced by the Cannikin and Milrow nuclear explosions beneath Amchitka Island was observed at vertical arrays of subsurface stations in borings offset 90 meters from the shot holes and at surface stations at distances ranging from surface zero to about 10 kilometers. Both acceleration and particle velocity time histories were recorded: vertical components only in the vertical arrays and three orthogonal components at surface stations. Milrow results indicate Rayleigh waves in records from a horizontal range of one-half shot depth and beyond. Analysis showed the initial spall depth near 110 meters, with later spallation below 150 meters and between 30 and 90 meters. Surface data indicate spallation extended laterally to four times shot depth. Cannikin data were truncated at about 1.8 seconds by power circuit malfunction. Peak motion was recorded at all stations except that at 10.4 kilometers before loss of power. Preliminary comparison with Milrow data indicates slightly greater peak motions from the more energetic Cannikin explosion. (auth)

28013 (USGS-474-133) EXPLOSION-INDUCED SURFACE FRACTURES OF SELECTED ANNOUNCED UNDERGROUND NUCLEAR TESTS, YUCCA FLAT, NEVADA TEST SITE, NEVADA, OCTOBER 1969 THROUGH DECEMBER 1970. Snyder, R. P.; Rogers, Susan (Geological Survey, Denver, Colo.). 1972. Contract AT(29-2)-474. 57p. (NTS-231). Dep. NTIS.

During the period from Oct. 1969 to Dec. 1970, personnel of the U. S. Geological Survey mapped the surface effects produced by 17 announced underground nuclear tests conducted in Areas 2, 3, 7, 8, 9, and 10, in Yucca Flat. Faults on which previous explosion-induced movement had been noted were reactivated by some tests, and previously unknown faults were activated by others. Some tests produced neither surface fractures nor collapse features. (auth)

28014 OIL STORAGE METHOD. Hague, Richard S. (to United States Atomic Energy Commission). U. S. Patent 3,643,441. 22 Feb 1972. Filed 5 May 1970.

Vessels for the storage of liquid, such as crude oil, are formed by detonating a nuclear (or conventional) explosive under the surface of a permafrost area such as occurs in arctic and subarctic regions, to form an open crater. The walls of such a crater are naturally sealed or may be easily sealed liquidtight by the freezing of water in the pore spaces of the host media, whereby oil (or other product) may be stored in the permafrosted crater without seepage loss. Further, permafrost (or frozen moisture between the permafrost and the product to be stored) in the fallback material (rubble) in the crater will form an effective separation barrier between the oil (or other product) and residual radioactivity formed as a result of the nuclear detonation. (Official Gazette)

28015 RECOVERY OF GEOTHERMAL ENERGY BY MEANS OF UNDERGROUND NUCLEAR DETONATIONS. Dixon, Rod P. (to United States Atomic Energy Commission). U. S. Patent 3,640,336. 8 Feb 1972. Filed 19 Jun 1970.

Geothermal steam is generated by setting off an underground nuclear detonation above a naturally hot stratum of igneous rock and thereafter introducing water into the formation above the hot stratum which has been made permeable by the nuclear detonation. (Official Gazette)

Detection Systems

Refer also to abstracts 28268 and 28269.

28016 (SC-DC-714489) SEISMIC SIGNAL COMPARISON FOR AN NTS EARTHQUAKE WITH NUCLEAR DETONATIONS. Tendall, Dorris M. (Sandia Labs., Albuquerque, N. Mex.). [1972]. 19p. (CONF-720311-2). Dep. NTIS.

From sixty-seventh annual meeting of the Seismological Society of America; Honolulu, Hi. (30 Mar 1972).

Seismic data from an earthquake are compared with data from underground nuclear explosions in the vicinity of the earthquake. The earthquake produced large S-compared with P-wave motion than did the nuclear explosions. Spectra of P and S waves were not definitive, but tended to show a broader spectra for the earthquake, i.e., the earthquake was relatively richer in energy at the high frequency end of the spectrum. Each event studied, earthquake or explosion, produced surface waves in which the energy peaked at nearly the same frequency at all measuring stations. The energy from the earthquake peaked at a lower frequency than did that from the explosion. The peaks were separated sufficiently to suggest a possible method of discrimination. (L.C.L.)

Civil Uses

28017 (AD-734332) QUARRYING WITH NUCLEAR EXPLOSIVES. Vesic, Aleksandar S. (Duke Univ., Durham, N. C. Dept. of Civil Engineering). Dec 1970. Contract DACW07-67-C-0058. 32p. (NCG-TR-13). NTIS.

Studies of the phenomenology of crater formation have been conducted at Duke University for many years with emphasis on the problems of large-scale excavation. The findings of those studies are reviewed with emphasis on their relevance to the concept of quarrying with large-yield explosions at relatively deep burial depths. Some simple rules are established for correlation of small-scale events under sloped terrain to analogous events under level terrain. Analyses were made of known cratering experiments in basalt and granite using the author's "incremental approach" as opposed to the conventional "scaled depth" approach. The results of these analyses were applied to the analysis of a proposed nuclear quarrying event at a hypothetical site in a granitic medium. (auth) (NTIS)

28018 (AEC-WO-603) AN INVESTIGATION OF THE FEASIBILITY OF BUILDING A HARBOR ON THE WEST COAST OF SOUTH AMERICA, USING EXPLOSIVE POWER OF NUCLEAR WEAPONS. A Preliminary Report. Zodtner, H. H. ([California Univ., Livermore. Radiation Lab.]). [nd]. 36p. Dep. NTIS.

Declassified 27 Oct 1971.

A preliminary investigation was made of 33 different ports on the west coast of South America to determine a good location for creating a deep harbor and the feasibility of using nuclear ex-

plosives for harbor excavation. Data such as topography, climate, railroad connections, population, and commerce for each port are presented. Arica, Chile was selected as the most promising location. The emplacement, quantity, and size of nuclear explosives required to achieve the desired harbor configuration are discussed, and the cost of harbor construction is estimated. (L.C.L.)

28019 (NCG-TR-35) MIDDLE COURSE I CRATERING SERIES. Fitchett, Donald J. (Army Engineer Nuclear Cratering Group, Livermore, Calif.). Jun 1971. 61p. Dep. NTIS.

During the period August through November 1970, the U. S. Army Engineer Nuclear Cratering Group conducted Project Trinidad, an extensive series of 1-ton single- and row-charge cratering experiments near Trinidad, Colorado. As part of Project Trinidad, the Defense Atomic Support Agency sponsored the Middle Course I series of four surface and two optimum depth cratering experiments. The cratering results of the DASA Middle Course I series combined with the results of the Project Trinidad tests provided the complete cratering curve for sandstone media. Optimum depth of burial (dob) was determined as 130 ft/kt$^{0.3}$. Scaled crater radius (r_s) and depth (d_s) at optimum dob were 167 ft/kt$^{0.3}$ and 94 ft/kt$^{0.3}$, respectively. Crater dimensions for stemmed and unstemmed detonations at optimum dob differed by 10 to 15%, the stemmed crater sizes being the larger. (auth)

28020 (NVO-37) PROJECT GASBUGGY: MANAGER'S REPORT. (Nevada Operations Office (AEC), Las Vegas). Nov 1971. Contract AT(29-2)-20. 174p. (PNE-G-79). Dep. NTIS.

The managers report on Project Gasbuggy includes information on: organizational planning and responsibilities; scientific operations such as pre- and post-shot evaluations, emplacement, on-site monitoring, and support facilities required; operations' coordination; safety preparations and evaluation of the radiological and seismic effects of the explosion; engineering construction and support activities; costs; security operations; and public information. The conclusions and recommendations of the industrial participant, El Paso Natural Gas Co., and of the AEC participants are presented. (L.C.L.)

28021 (ORNL-TM-3760) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS (CANE): PROGRESS REPORT FOR JULY 1 TO DECEMBER 31, 1971. Arnold, W. D.; Crouse, D. J. (Oak Ridge National Lab., Tenn.). 27 Mar 1972. 14p. Dep. NTIS.

Studies were continued of the potential radioactive contamination of natural gas stored in cavities formed with nuclear explosives. Contamination of the gas with tritiated water vapor could be minimized by using a low tritium yield fission device to form the storage cavity and by dehydrating the gas (possibly after scrubbing it with water) upon withdrawal from the cavity. Most of the ^{85}Kr and some of the tritiated water could be removed from the storage cavity prior to gas storage by purging with air. With these provisions, the radioactive contamination of the gas should be extremely low. A study has been started of methods for disposing of dilute tritiated water that is removed from the gas in gas stimulation and gas storage applications. (auth)

28022 (SC-RR-720001) EJECTA FROM A ROW-CHARGE CRATERING EXPLOSION. Vortman, L. J.; Long, J. W. (Sandia Labs., Albuquerque, N. Mex.). Mar 1972. 360p. Dep. NTIS.

Nine 64-lb cast-TNT spherical charges were buried 6 ft deep and 8 ft apart in a row in dry lake playa, and were detonated simultaneously. Deposition of the cratered material was analyzed by the use of particulate tracers 1 to 2 mm in size. The tracers had been placed in a grid pattern of depth and distance in 5 vertical planes within the material to be cratered. An unexpected finding was that considerable material near the end charge was transported longitudinally toward the opposite end of the row. This material was from two separate sources and, apparently, transported by different mechanisms. (auth)

28023 (UCRL-51153) GAS ANALYSIS RESULTS FOR PROJECT RULISON PRODUCTION TESTING SAMPLES. Smith, C. F. Jr. (California Univ., Livermore. Lawrence Livermore Lab.). 29 Nov 1971. Contract W-7405-eng-48. 27p. (PNE-R-58). Dep. NTIS.

Results obtained by chemical and radiochemical gas analysis of samples taken from the flowing gas stream during the Project Rulison nuclear gas stimulation experiment are presented and discussed. These results cover the production testing period from October 26, 1970 through April 23, 1971, when nearly 420 million ft^3 of gas were flared in three testing periods. The combined effects of production and dilution of the initial chimney gases resulted in a reduction in the radionuclide concentrations present in the produced gas by about a factor of 50. The most significant radionuclide, tritium, decreased from 176 to 3.7 pCi/ml of produced gas, while ^{85}Kr changed from 150 to 2.9 pCi/ml. Throughout the testing period the distribution of tritium among the gases was approximately 81% in CH_4, 11% in H_2, 6% in C_2H_6 and 1% in C_3H_8. The chemical composition of the produced gas also changed significantly during production. Carbon dioxide concentration dropped from 48% to 22%, and that of H_2 from 15.7% to 1.0%. Concentrations of the components of formation gas increased through the test period by about a factor of 2. The methane concentration went from 32.8% to 71.6%, that of ethane from 1.7% to 3.6%, and that of propane from 0.3% to 1%. The anomalous behavior of CO_2 is due to late-time introduction of this material from at least two sources. One of these, containing ^{14}C and accounting for a 15% increase in the total CO_2 available, may be evidence for the release of gas dissolved in chimney water. The second source released CO_2, which was free of ^{14}C, and accounted for an 8% increase in total CO_2 in the chimney. The specific activity of hydrogen gas was constant throughout the test, and consistent with the maintenance of tritium exchange equilibrium between water and hydrogen gas. No other tritiated species were observed in tritium exchange reactions. Based on an assumed total quantity (1100 Ci) of ^{85}Kr in the preproduction chimney gas and the reasonably constant total gaseous tritium-to-^{85}Kr ratio, it was inferred that a total of 1300 Ci of tritium was present in the chimney gas before production. This is 13% of the total of 1g of this material, which was predicted to be present following the detonation. The remaining 87% is presumed to be bound in nonvolatile compounds, water and solidified melt. (auth)

28024 PRODUCTION OF TRANSURANIUM ELEMENTS IN A THERMONUCLEAR NEUTRON FLASH. Eberle, S. H. (Univ., Karlsruhe, Ger. Gesellschaft fuer Kernforschung, Karlsruhe, Ger.). Kerntechnik; 14: No. 2, 65-71(Feb 1972). (In German and English).

The neutron flash of an underground thermonuclear explosion makes it possible to synthesize neutron-rich transuranium nuclides by prompt neutron capture. The highest yields are obtained with ^{238}U as the starting material; higher elements are less suitable because of the higher losses due to induced fission. The most successful experiment so far was the HUTCH explosion actuated in 1969 using 17.8 g of ^{238}U which yielded 0.14% of Cf and 1.2 ppM of ^{257}Fm, among other nuclides. The technology of detonation and the processing of the explosion products are sufficiently advanced to make the thermonuclear production of ^{250}Cm, ^{252}Cf and ^{257}Fm appear to be competitive with reactors for large requirements. (auth)

28025 PROJECT RULISON: SUMMARY OF RESULTS AND ANALYSES. Reynolds, Miles Jr. (Austral Oil Co., Inc., Houston, Tex.). Nucl. Technol.; 14: No. 2, 187-93(May 1972).

The results of Project Rulison confirm the technical feasibility of stimulating the Mesaverde formation in the Rulison Field with nuclear explosives. Testing of the nuclear stimulated well provided the data necessary to analyze the well's performance and to predict the long term reservoir behavior. Continuous chemical and radiochemical data were obtained to aid in analysis of well performance, explosive yield calculations and surveillance for public health and safety assurances. Future activities at Project Rulison will concern the regulatory matters with respect to marketing of the gas. (auth)

Protective Structures and Equipment

28026 (DP-1262) THERMAL EVALUATION OF WATER-EXTENDED POLYESTER. McMillan, T. S. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Mar 1972. Contract AT(07-2)-1. 18p. Dep. NTIS.

Cast water-extended polyester, containing ethylene glycol and neutralized boric acid, was not damaged by a temperature of −40°C. Exposure of one surface of a steel-encased casting to 800°C for 30 minutes caused damage to a depth of 0.6 cm. (auth)

28027 IMPROVEMENTS IN A NUCLEAR RADIATION PROTECTION CASING FOR A HYPODERMIC SYRINGE. Bertoni, Bruno; Delfosse, Jean (to Commissariat a l'Energie Atomique). British Patent 1,269,290. 6 Apr 1972. Priority date 16 Dec 1969, France.

A nuclear radiation protection casing for a hypodermic syringe is described comprising a Pb box enclosing a space, a Pb cover, a bottom support member for receiving the body of a syringe in the space and a top support member rigidly secured to the cover and incorporating an orifice via which the space communicates with the exterior. The orifice is dimensioned to receive the end portion of the syringe body. A stirrup-shaped member is included in the space to secure the piston head. (J.R.D.)

28028 POSSIBILITIES FOR VISUAL INSPECTION WITHIN THE BIOLOGICAL SHIELD OF A REACTOR USING A TELE-

VISION CAMERA. Feldmann, J. (Allianz Versicherungs-AG, Munich). Allianz Ber. Betriebstech. Schadenverhuetung; No. 15, 12-20(1971). (In German).

In 1970, the Allianz Versicherungs-AG—through its Technical Service Division—carried out visual inspections of activated reactor pressure vessels with the aid of a television camera. The fault detection possibilities of visual inspection are of course limited to surface faults. A particularly important advantage of this method, however, lies in the ability to effect assessment of components, which due to their constructional features escape examination when applying other inspection methods. The cylindrical-shaped camera being only 61 mm in diameter, it is thus able to penetrate to locations which would otherwise be inaccessible. In the assessment of surface areas, important data is furnished by the reflection given off. The technical equipment comprises a television camera with built-in lighting, the requisite control and operating apparatus and a picture storage unit, which is indispensable for documentation and subsequent comparison evaluation. During the course of the inspections, various methods of manipulation were tried out, viz. with the aid of the refueling platform, by use of a special manipulator, and by manipulating the camera inside the pressure vessel suspended from its supply cable. (INIS)

28029 RADIOACTIVE SOURCE SHIELD WITH SAFE POSITION INDICATOR. Jeffries, Luther R. Jr.; Thompson, Charles F. (to General Nuclear Inc.). U. S. Patent 3,643,096. 15 Feb 1972. Filed 27 Feb 1969.

Apparatus for indicating when a radioactive source capsule is in a safe position within its shield comprises a gamma-sensitive photoconductor located in the shield in close proximity to the safe location of the radioactive source. The photoconductor operates a visual indicator through electrical circuitry designed so that a positive indication is given when the radioactive source is in its safe position. (Official Gazette)

28030 EFFICIENCY TESTING OF AIR-CLEANING SYSTEMS CONTAINING DEVICES FOR REMOVAL OF PARTICLES. ANSI N101.1-1972. New York; American National Standards Institute, Inc. (1972). 21p.

A standard is presented which provides a method for measuring the particle removal efficiency of a system containing one or more particulate air-cleaning devices by means of an in-place test. The installed air-cleaning device, or devices when more than one is used in a system, is confronted with an aerosol of DOP of proper particle size. The concentration of the aerosol is measured before and after the device by means of light-scattering, photometric techniques, and the overall filtration efficiency is then calculated from the two concentration values. A standard test method is described to provide a uniform basis for assessing the filtration efficiency of a system containing one or more particulate air-cleaning devices. It is the purpose of the in-place test to determine the efficiency of the system in such a manner that any penetration of the test aerosol through the devices, or leakage of the test aerosol around the devices, is included in the results. This standard does not specify performance criteria for the purpose of evaluating systems for specific service conditions. (auth)

28031 ANOTHER FAILURE OF A COMMERCIAL X RAY SHUTTER SYSTEM. Leenhouts, H. P. (Instituut voor Toepassing van Atoomenergie in de Landbouw, Wageningen, Netherlands). Health Phys.; 22: No. 4, 413-14(Apr 1972).

A failure of a safety interlocking system of a Philips deep therapy x-ray instrument (250kV, 15mA) is described. A scientist received a dose of 21 Rem of 30 to 70 keV at chest level. It was concluded that the mechanical brake controlling the completion of the shutter closure failed to work due to wear on the brake block. The shutter stopped in a partly open "dead" position not detected by the fail-safe switch. The following conclusions were drawn: the high voltage of the x-ray machine must be switched off before opening the door of the irradiation room, (if the voltage is on, the door should be locked electrically); when it is not possible to switch off the high voltage, the shutter must be closed before the door can be opened; and the position of the shutter must be indicated and must open the door. (UK)

28032 SAFE VENTILATION OF RADIOACTIVELY ENDANGERED ROOMS. TECHNICAL AIR INSTALLATIONS FOR THE CONTROL AREA OF THE NUCLEAR POWER PLANT OBRIGHEIM. Krueger, M.; Seggewies, H. Umwelt; 1: 22-6 (1971). (In German).

One of the main tasks of ventilation installations in a nuclear power plant is the avoidance of a controlled release of air from the buildings within the control area such as reactor building, reactor emergency set building, and the storage building for radioactive wastes. The duties of technical air installations in a nuclear power plant are described using the example of the 300 MW plant KWO. A detailed description is given of personnel and siting radiation protection measures according to the First Radiation Protection ordinance of the Federal Republic of Germany. The setup of the Individual Installations with respect to their duties is given. From a block diagram of the total installation with a description of the most essential components, the interaction can be seen. Special control problems and their solutions are indicated. (INIS)

Safety Engineering

Refer also to abstracts 28032 and 28687.

28033 (BLG-460, pp 4,1-7) SAFETY STUDIES. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 1970. In Annual scientific report, 1970.

ATMOSPHERE—diffusion in Belgian, during 1970
AUTORADIOGRAPHY—method for high-speed measurement of alpha activity from plutonium on air filters
BELGIUM—radiation monitoring of environment in, during 1970
BIOLOGICAL MATERIALS—analysis for radioisotopes, development of methods for
CESIUM-137—content in Belgian food during 1970
CHARCOAL—sorptive properties of filters of, for iodine
FOOD—cesium-137 content of Belgian, during 1970
—strontium-90 content of Belgian, during 1970
NUCLEAR MATERIALS MANAGEMENT—safeguards for, research programs on
RADIOACTIVE WASTE—disposal of, research programs on
SAMPLING—method for smear-type, for radioactive materials on surfaces
STRONTIUM-90—content in Belgian food during 1970
XENON-133—clearance from human body, measurement of time for
XENON-135—clearance from human body, measurement of time for (J.R.D.)

Vacuum Engineering

Refer also to abstract 30012.

28034 HIGH VACUUM INSTALLATION WITH CRYOGENIC PUMPING AT FORE-VACUUM AND HIGH-VACUUM STAGES. Lazarev, B. G.; Makarov, V. I.; Azhazha, V. M.; (and others) (Physical-Technical Inst., Kharkov). Dokl. Akad. Nauk SSSR; 201: No. 2, 321-3(11 Nov 1971). (In Russian).

The vacuum installation described relies on special adsorption-condensation pumps at all stages with the total exclusion of oil pumps. Using liquid He and H_2 in the adsorption-condensation pumps, a vacuum of 2×10^{-9} torr was attained in the 500 mm × 500 mm stainless steel working chamber. (K.S.W.)

ENVIRONMENTAL AND EARTH SCIENCES

Minerals and Ores

28035 (CEA-R-4054) PRECAMBRIAN SERIES IN GABON: FRANCEVILLIAN, SEDIMENTOLOGY, GEOCHEMISTRY, AND RELATION WITH ASSOCIATED MINERAL DEPOSITS. Weber, Francis (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar 1971. 339p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Strasbourg Univ. (France). Faculte des Sciences.

The nonmetamorphic Precambrian series, Francevillian, is described. An attempt is made to classify the Moanda Mn deposit and the Monana U deposit in relation to their sedimentological and paleogeographic nature. A lithostratigraphic column was established and the following regions distinguished: a deep region in which the heavily and lightly folded series are mainly volcano-sedimentary (spilitic volcanism): an epicontinental region, where the submarine rises separate several basins. It is suggested that the Mn deposits are associated with three mechanisms: Mn derived from spilitic volcanism concentrated in a carbonate ampelitic sediment, its subsequent oxidation, and its enrichment due to weathering. The U deposits in the basal sandstone are probably related to the circulation of ground water enriched in U by the leaching of acidic volcanic ash. The age of Francevillian, determined by Rb/Sr and K/A analysis, is 1740 million years. (France)

28036 (RISO-228) FISSION TRACK RADIOGRAPHY OF URANIUM AND THORIUM IN RADIOACTIVE MINERALS. Wollenberg, Harold (Danish Atomic Energy Commission, Risoe, Research Establishment). Jul 1971. 40p. Dep. NTIS (U. S. Sales Only).

The fission track method is a quick, relatively simple, and inexpensive technique to determine the location and abundance of uranium, and in some cases thorium, in thin or polished sections of rocks. Thermal neutrons induce fission in ^{235}U, while ^{232}Th and ^{238}U fission with fast-neutron bombardment. Therefore, sections with appropriate track detectors are exposed first to thermal neutrons to induce only U, then to fast neutrons for U plus Th. The detectors are etched to reveal the damaged areas (tracks) caused by passage of massively charged fission fragments. High quality muscovite mica is the preferable track detector for minerals with U contents greater than 10 to 15 ppM, mainly because tracks in mica are easy to recognize. Polycarbonate plastic (lexan or makrofol) is preferred as a track detector for low contents of U and Th because this material contains essentially no inherent U, therefore, it has no background track density. Thorium is determined successfully if the Th/U ratio of the mineral is sufficiently large. Relative errors (from counting statistics) in Th are less than 25% if Th/U is greater than 3, for ratios less than 3 the errors increase rapidly and exceed 40 to 50% if Th/U is less than 1. The method was applied to the study of U and Th in rocks of the Ilímaussaq intrusion, South Greenland, and in a mineralized fault zone occurrence in East Greenland. At Ilímaussaq, the most intense U and Th mineralization is associated with lujavrites of the Kvanefjeld area, where the mineral steenstrupine controls whole-rock radioactivity. Arithmetic mean values of Th and U in steenstrupine are 23,000 and 6200 ppM, respectively. In lujavrites of the Kangerdluarssuk area, rock radioactivity is controlled by eudialyte, whose Th and U contents are at least an order of magnitude less than those in steenstrupine. Thorium and uranium contents of monazite, thorite, and pigmentary material were also investigated. Fission track examinations of thin sections of mineralized fault zone breccia from the East Greenland occurrence indicated that U is strongly associated with limonitic material in thin fluoritized veinlets, and is occassionally found concentrated near the edges of reddish opaque (hematite?) grains. By combining fission track results with an electron microprobe study of the minerals one may be able to correlate the abundance of Th and U with other elements. (auth)

28037 GEOCHEMICAL PROSPECTING IN THE SEARCH FOR LEAD, ZINC, AND COPPER IN SOME REGIONS OF TRENTINO-ALTO ADIGE. Dall'Aglio, M.; Da Roit, R.; Gragnani, R.; Orlandi, C. (CNEN, Rome). Econ. Trentina; No. 2-3, 127-35(1970). (In Italian). (RT/GEO(70)11).

The results achieved in the course of a geochemical survey for Cu, Pb, and Zn are reported. The survey, carried out by Geomining Laboratory of C.N.E.N., was made for the Bureau of Mines of the Trentino-Alto Adige Region. The areas investigated were the left side of Pusteria Valley (700 square km) and the left side of Adige Valley (200 square km) in correspondence of Ala town. More than 400 samples of stream sediments and stream waters were collected over an area of about 1,000 square km (1 sample every 2 square km). All water samples were analyzed for all major constituents and of U, Cu, Zn, and heavy metals. The alluvial samples were analyzed for U, Cu, Zn, and Pb. Some major anomalies for Zn and Cu were detected both in alluvia and water samples. These anomalies are important for detecting new ores of the above mentioned minerals. (auth)

28038 U-O BOND LENGTHS AND FORCE CONSTANTS IN SOME URANYL MINERALS. Wilkins, Ronald W. T. (Univ. of Queensland, Australia). Z. Kristallogr.: 134: No. 3-4, 285-90 (Nov 1971).

Force constants for U-O bonds in uranyl compounds are readily calculated from the frequencies of the symmetric and asymmetric stretching vibrations determined from Raman and infrared spectroscopy. U-O bond lengths have been calculated from bond force constants using Badger's relation for seven minerals and three related compounds. Where x-ray data exist there is satisfactory agreement between bond lengths determined by the two methods. (auth)

28039 THORIUM-RICH VEINS OF HALL MOUNTAIN IN NORTHERNMOST IDAHO. Staatz, Mortimer H. (Geological Survey, Denver). Econ. Geol.; 67: No. 2, 240-8(Mar-Apr 1972).

Thorium-rich veins occur in an area of about 0.5 sq. mile about 3 miles east of the border station of Porthill, Idaho. Some of these veins are of particular interest because they have more thorium, coarser grain size, and less iron oxides than other known thorium veins in the US. The veins on Hall Mountain cut Precambrian quartzite and quartz diorite. The quartz diorite is one of several Purcell sills that intrude Belt rocks. Most of the veins occur adjacent to the upper contact of the thickest sill on Hall Mountain. The veins strike from N. 42° W. to N. 30° E. and dip steeply. They range in known length from 6 to 700 ft and in thickness from thin seams to 13 ft. The thorium content of 23 samples from 11 veins ranged from 0.0095 to 21.0%. Twelve samples had a thorium content greater than 1%. The thorium and the mineral content of the veins are erratic, varying both among the veins and within an individual vein. Quartz and calcite are the principal gangue minerals and thorite is the principal thorium mineral. Chlorite, magnetite, limonite, pyrite, and biotite occur in many samples of these veins. In addition the following minerals in general order of abundance were found in a few of the samples: goethite, sphene, zircon, apatite, plagioclase, allanite, chalcopyrite, rutile, actinolite, pyrrhotite, muscovite, hematite, epidote, ilmenite, malachite, chrysocolla, monazite, cenosite, jarosite, dolomite, fluorite, and an unknown brown thorium mineral. Mineralogically these veins differ considerably from most thorium veins. A comparison of the veins of Hall Mountain with those at Lemhi Pass on the Idaho-Montana border indicates the following differences: at Hall Mountain veins contain only sparse limonite or hematite, but at Lemhi Pass these minerals are both widespread and abundant; at Hall Mountain plagioclase was the only feldspar identified and it is rather sparse, whereas at Lemhi Pass microcline is one of the common gangue minerals, and plagioclase was not noted; at Hall Mountain allanite is the second most common thorium and rare-earth mineral, and monazite and cenosite were found in one sample each, whereas at Lemhi Pass monazite is the second most common thorium and rare-earth mineral, brockite is common, and allanite is rare; at Hall Mountain sphene, zircon, and ilmenite are present, but are absent from Lemhi Pass; and barite is absent from Hall Mountain but common at Lemhi Pass. (auth)

28040 PROCEEDINGS OF THE 94th CONGRESS OF THE LEARNED SOCIETIES. VOLUME 2. MATHEMATICS. PHYSICS. GEOLOGY. MINERALOGY. Conference Held at Pau, France, April 8, 1969. Paris; Bibliotheque Nationale (1971). 323p. (In French). (CONF-690461-(Vol.2)).

Thirty-five papers were presented at this congress. Three of them are processed for NSA. The other papers cover mathematics, physics, mineralogy, geochemistry, geology and geophysics. (France)

For abstracts of individual papers see: 28041, 28042, and 28098.

28041 PRELIMINARY STUDY OF THE RADIOACTIVITY OF QUIBERON GRANITE (MORBIHAN). Coppens, Rene; Mayanda, Marcel. pp 211-21 of Proceedings of the 94th Congress of the Learned Societies. Vol. 2. Paris; Bibliotheque Nationale (1971). (In French).

From ninety-fourth national congress of the Learned Societies; Pau, France (8 Apr 1969). See CONF-690461-(Vol.2).

The sand of the large beach at Quiberon contains a small proportion of uraninite crystals, and in addition very radioactive opaque grains, which have not been identified. Although the Quiberon granite possesses only a weak overall radioactivity (30c/s AVP, 1.5α/cm^2/s), it contains uraninite crystals, generally included in the feldspar, even in samples taken from the surface. Other radioactive minerals are much more rare and contained in very small proportions. In contrast, the U content may be very high reaching 16μg/g. Radiogeological studies of Quiberon granites should thus either lead to the localization of uranium deposits, or indicate why such deposits do not exist. (France)

28042 GEOCHEMISTRY OF U AND Th IN THE VOLCANIC ROCKS OF THE MERIDIONAL VOSGES. Stussi, J. M. (Univ., Nancy). pp 229-40 of Proceedings of the 94th Congress of the Learned Societies. Vol. 2. Paris; Bibliotheque Nationale (1971). (In French).

From ninety-fourth national congress of the Learned Societies; Pau, France (8 Apr 1969). See CONF-690461-(Vol.2).

The geochemical evolution of the U and Th of the volcanic rocks of the Meridional Vosges is considered on the basis of the principal magmatics of the two volcanic associations present. It is suggested that if the two elements are apparently linked with the alkaline development of the magmatism, they might be subjected to irregular variations which are independent of the overall magmatic evolution. Certain hypotheses on the probable cause of these geochemical variations are advanced. (France)

28043 URANIUM: AN ADDITIONAL RAW MATERIAL IN THE PRODUCTION PROGRAM OF THE RHEINISCHE BRAUNKOHLENWERKE AG. Arnold. Braunkohle; 23: No. 8, 257-66(1971). (In German).

A forecast is given of the development of the total power demand and the gross current generation of the Federal Republic of Germany (FRG) to the year 2000. The energy balance of the fission of ^{235}U is followed by estimates of the total power consumption of the western world in the year 2000, of the annual uranium demand (western world, western Europe, and FRG) until 1980, and of the western world's uranium resources involving recovery costs below 10 $/lb U_3O_8. An account is given of the efforts to guarantee the uranium supply for the FRG, including a survey of the regions of prospecting throughout the world. The most important problems of prospecting, exploration and ore dressing are outlined, with particular consideration to costs. (INIS)

Radioactive Effluents

Refer also to abstracts 27827, 27854, 27887, 27996, 28056, 28057, 28059, 28072, 28082, 28101, 28115, 30297, 30306, 30338, and 30355.

28044 (DOCKET-408102-4) HIGHLAND URANIUM MILL. Supplement to Environmental Report, Clarification of Humble's Obligations. (Humble Oil and Refining Co., Houston, Tex. Minerals Dept.). 10 Apr 1972. 2p. Dep. NTIS.

28045 (DOCKET-408102-5) HIGHLAND URANIUM MILL. Draft Detailed Statement on Environmental Considerations Related to the Proposed Issuance of an Operating License. (Division of Materials Licensing (AEC), Washington, D. C.). 25 Apr 1972. 48p. Dep. NTIS.

The Highland Uranium Mill is an acid-leach, solvent-extraction uranium ore processing plant with a capacity of about 2000 tons of ore per day. The temporary (12 to 14 years) reassignment of use of about 3200 acres of land normally used for sheep grazing, extraction and recovery of approximately 32 million pounds of uranium concentrates, and creation of a stabilized tailings pile are among the aspects considered. Various alternatives to the project are discussed. (M.C.G.)

28046 HEALTH PHYSICS AND THE ENVIRONMENT. Morgan, K. Z. (Oak Ridge National Lab., Tenn.). pp 3-21 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

Health physics is the science and profession for the protection of man and his environment from the harmful effects of all forms of electromagnetic radiation while at the same time maximizing its beneficial applications. In the early period (1942 to 49), there were no recommended national or international levels for the disposal of radioactive waste to the environment, and the health physicist was forced to set his own standards. Although these standards were considered by some at the time as conservative by a factor of 1000, they were larger by factors of 200 to 7000 than those commonly used today. Some early methods for disposal of radioactive waste at Oak Ridge National Laboratory and the more recently developed methods for disposal in hydrofractured formations and in bedded salt are discussed. Environmental sampling techniques used by the early health physicists are reviewed, and the role of the health physicist in determining the critical radionuclides, the critical environmental pathways and the critical segment of the population is emphasized. The health physicist is cautioned not to neglect the principal source of population exposure to man-made radiation, namely, medical diagnostic exposure. Some early objections to radiation ecology research are recalled, and several interesting findings of the Oak Ridge National Laboratory Radiation Ecology Program are indicated. It is emphasized that the health physicist has a major responsibility in identifying the critical segment of a population which receives the highest environmental radiation exposure, and if this is done properly, a bonus reward in terms of improved public relations can be expected by the nuclear energy industry. It is concluded that the present radiation protection standards are reasonable and satisfactory, but they do not contain an unnecessarily large margin of safety. It is urged that the population dose limits should include exposure from medical diagnosis and must continue to maintain a large reserve which, it is hoped, will never be used. (auth)

Radioactivity Transport and Monitoring

Refer also to abstracts 27797, 27801, 27803, 27806, 27828, 27929, 28046, 28104, 28115, and 28266.

28047 (HASL-249) FALLOUT PROGRAM QUARTERLY SUMMARY REPORT, DECEMBER 1, 1971-MARCH 1, 1972. Hardy, Edward P. Jr. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Apr 1972. 434p. Dep. NTIS.

Activities related to the HASL fallout program conducted during the period from Dec. 1, 1971 to Mar. 1, 1972 are presented in ten sections. A separate abstract was prepared for each of 8 sections. One section appeared previously in NSA as 25: 54450. One section was not within the scope of NSA. (L.C.L.)

For abstracts of individual sections see: 27991, 28048, 28049, 28062, 28063, 28075, 28077, and 28084.

28048 (HASL-249, pp I.25-45) PLUTONIUM LEVELS IN THE ROCKY FLATS ENVIRONS: CY 1971. Boss, M. R. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 1 Apr 1972.

In Fallout program quarterly summary report, December 1, 1971-March 1, 1972.

Results from the environmental plutonium surveillance program conducted on and around the Rocky Flats Plant during 1971 are summarized. The surveillance program is continually refining natural background measurements and determining if increases in radioactivity, and plutonium in particular, are taking place. Plutonium concentrations in air samples indicate that no health hazard exists from plant operations. Concentrations of both plutonium and americium in water samples never exceeded 1% of the applicable standard, on an average basis. Based on 243 analyses of soil made at the plant, an upper estimate of 0.52 curies of plutonium is dispersed over about 2000 acres of uncontrolled area. (auth)

28049 (HASL-249, pp III.1-103) DATA FROM SOURCES OTHER THAN HASL. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Apr 1972.

In Fallout program quarterly summary report, December 1, 1971-March 1, 1972.

Some fallout studies conducted by other organizations in the U.S. and abroad send information to HASL for dissemination in the HASL Quarterly Reports. The submitted data are reproduced essentially as received with no HASL interpretation. Included are reports on environmental radioactivity monitoring in New Zealand during Jan. to Aug. 1971 and on monitoring of atmospheric radioactivity and fallout deposition at Ispra during Oct. through Dec. 1971. (L.C.L.)

28050 NUCLEAR POWER INDUSTRY'S NEED FOR RAPID AND ACCURATE ESTIMATION OF RADIOACTIVITY IN THE ENVIRONMENT. Bryant, Pamela M. (National Radiological Protection Board, Harwell, Eng.). pp 33-42 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

The employment of nuclear power reactors to generate electricity entails some risk, however slight, of accidental release of radionuclides to the atmosphere in the event of serious maloperation or major failure of a reactor or the associated fuel production and reprocessing facilities, or during transport of irradiated fuel. Possible sources of airborne radioactivity are reviewed, and it is concluded that, in the context of accidental releases, reactor operation and transport of irradiated fuel elements appear to be the most significant. The quantity and nature of postulated radioactive releases from present and future reactor types are examined. The relative significance of various routes of radiation exposure of members of the public due to these postulated releases is described. Special attention is paid to the availability and feasibility of counter measures to reduce or prevent radiation exposure of the public. Rapid and accurate analysis of radioactivity in the environment is likely to be of little more value than methods already available unless counter measures can be taken. Conversely, if counter measures are urgently required, results must be available quickly and be meaningful. The difficulties inherent in sampling and interpretation of results are discussed. Failure of a transport container involves special problems as there may be no skilled personnel in attendance and it may be difficult to get any measurement at all. The problems are examined with reference to present-day and possible future irradiated fuel transport requirements. It is concluded that there is only a limited range of counter measures for which rapid and accurate methods of measurement in the environment are likely to be justified. (auth)

28051 ASSESSMENT OF ENVIRONMENTAL HAZARDS FOLLOWING NUCLEAR REACTOR ACCIDENTS. Macdonald, H. F. (Berkeley Nuclear Labs., Eng.). pp 43-54 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

Theoretical models were developed describing the build-up of fission products in irradiated nuclear fuel and the behavior of these in a reactor and subsequently in atmosphere under definable accident conditions. These models were incorporated into a computer program EERIE (Environmental Evaluation of Radioactive Isotopic Effluents) which enables inhalation doses to body organs, cloud beta and gamma doses, and the quantity of radioactivity deposited on the ground in the area surrounding the site of a release of activity to be evaluated. The results of a computer study of a representative range of reactor accidents are described. The accidents chosen as examples are specific to gas-cooled reactors, but the methods used can in principle be applied to any reactor type. The effects of factors which influence the nature or magnitude of the releases, such as isotopic release fractions from the damaged fuel and plate-out within the reactor coolant circuit, and the associated hazards are outlined. In addition compilations of the gamma spectra of fission product elements are used to make theoretical estimates of the gamma spectra which would be obtained from air sample filters taken downwind of the site of a reactor accident. The data obtained in this study are critically examined in order to provide guidance on the best methods of obtaining adequate monitoring results with sufficient speed to institute effective precautionary measures. The comprehensive nature of the calculations, which enables the complete history of the isotopic content of the damaged fuel to be followed continuously from the time of its release from the fuel through its dispersal in the atmosphere, makes it possible to identify those parameters which are important in determining sampling and monitoring techniques. In addition it makes it possible to evaluate the usefulness of different analytical methods at various stages during an incident. (auth)

28052 RAPID PHYSICAL METHODS FOR RADIOACTIVE ENVIRONMENTAL MONITORING. Kiefer, H.; Maushart, R. (Kernfroschungszentrum, Karlsruhe, Ger.). pp 281-9 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

Rapid methods for measurement of radioactivity may serve several purposes, the most important one being the rationalization of the routine tasks of radiation protection in nuclear industry and research. Other aims are emergency measurements after nuclear accidents, and the identification of unknown radionuclides to determine the degree of hazards presented by them. In any case, the rapidity of the methods as a whole will be governed by the sum of the individual steps, such as sample collection, preparation, chemical treatment, physical measurement, and data processing and evaluation. Furthermore, the rapidity can only be evaluated in close connection with the accuracy of the method that is needed for a given purpose. For the measurement of large numbers of samples in the laboratory, it is advisable to prepare the samples in such a way that only an assessment of the relative intensity has to be performed. This means that the composition of the activity and its probable alterations have to be known beforehand from earlier identification measurements. Regarding the measuring technique itself, the large-area proportional counter still seems to be the optimal detector when beta activity has to be detected. For monitoring gamma and alpha activity, however, spectroscopic methods using solid-state detectors are rapidly gaining a place. The performance and limits of all three methods are discussed, and typical examples of their application are given. (auth)

28053 COMBINED ENVIRONMENTAL RADIOACTIVITY MEASUREMENTS FOR RAPID ESTIMATION OF THE GAMMA-RADIATION FIELD. Pensko, J.; Gwiazdowski, B.; Jagielak, J.; Biernacka, M.; Mamont, K. (Inst. for Nuclear Research, Swierk, Poland). pp 443-58 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

The main task of dosimetric survey teams in a big-scale radiation accident is rapid delivery of the data required for reasonable control measures. The action undertaken depends on the manner of irradiation of the affected population groups. This is connected with the effectiveness of external or internal irradiation of the body, which depends mainly on the composition and physical nature of the radioactive material deposited on plants and on the ground. The problem of critical nuclides and critical pathways in which the radioactive contaminants irradiate the human body is of great importance. The rapid delivery of the required data demands application of special field methods, which are particularly useful in various accident situations that cause environmental contamination. The basic field methods of controlling radioactive contamination of the natural environment, in which the detection limit of the contaminated ground by gamma-emitting radionuclides is of great importance, are discussed here. This detection limit is mostly dependent on previous knowledge of the natural gamma background radiation in the area of foreseeable contaminations. An example of a combined survey method of the environmental gamma-radiation field is described. The method may be used for monitoring environmental radioactivity in the vicinity of nuclear installations in normal operations as well as for rapid recognition and assessment of accidents in emergencies. (auth)

28054 METHODS OF MEASUREMENT FOR RADIATION MONITORING OF THE ENVIRONMENT IN AUSTRIA. Tritremmel, C. (Oesterreichische Studiengesellschaft fuer Atomenergie, Vienna). pp 615-20 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

A detailed description is given of the methods of measurement used for radiation monitoring of the atmosphere at ground level. The points in time at which these measurement data are to be obtained and evaluated are closely defined. Together with large-scale monitoring of facilities, provision is made for smaller monitoring devices. After the measurement data have been obtained and evaluated, safety and protection measures for the staff and for the environment as a whole come into operation. In respect of the latter, special organizational measures have been adopted in Austria with a view to guaranteeing the protection of the population and of facilities. (auth)

28055 RAPID METHODS FOR RADIOACTIVE ENVIRONMENTAL MONITORING IN THE FEDERAL REPUBLIC OF GERMANY. Sansoni, B. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Neuherberg, Ger.). pp 655-75 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

In the State Committee for Atomic Energy of the Federal Republic of Germany the subcommittee for radioactive monitoring of food and other biological materials established in 1966 a working group on rapid methods. It had the duty of assisting the stations in the radioactivity surveillance network to extend fallout

analysis to emergency situations, to study the basic considerations for the use of rapid methods in such situations, to stimulate the development of new rapid methods in this field, and to evaluate them by intercomparison runs between different laboratories. Several aspects of the meetings of this group are discussed in detail: definition of rapid; use of rapid methods in the laboratory for normal radioactive environmental surveillance; use of rapid methods in emergency situations with radionuclides; detection limit, precision, accuracy; use of field methods compared with laboratory methods; the trend for physical methods without chemistry; the importance of gamma spectroscopy with Ge(Li) detectors; result of the intercomparison run for determination of ^{131}I, ^{137}Cs, ^{140}Ba, and ^{40}K in milk (and water) by gamma spectrum stripping; preliminary result of the intercomparison run for ^{89}Sr, ^{90}Sr in milk by chemical methods according to Montag's method; development of rapid ashing methods; and future work. (auth)

28056 EMERGENCY PLANNING AT NUCLEAR INSTALLATIONS AS A BASIS FOR RAPID MONITORING PROGRAMS. Schwibach, J. (Bundesgesundheitsamt, Berlin). pp 679-93 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

Rapid methods for monitoring radionuclides in the environment within recent years have become of interest in the Federal Republic of Germany mainly for research and government laboratories engaged in monitoring environmental radioactivity. The application of rapid methods for determining and evaluating accidental releases of radionuclides has so far concerned only a few installations such as nuclear research centers and the first nuclear power plants within the local emergency programs and the district emergency planning of the competent authorities. Because of the increasing number of large nuclear power plants, the application of rapid methods to emergency planning is of great interest for reasons of safety and economy. In this connection, the question arises of the extent of monitoring programs for the determination and evaluation of accidental releases. Accidental releases of radionuclides range from small violations of licensed operational discharges to regional catastrophes in the case of a maximum release of the fission product inventory. The required efficiency of rapid methods depends on assumptions about the type and magnitude of the accidental releases of radionuclides as well as their dispersion into the environment, and the action levels of the radiation burden of the population under emergency conditions based on medical advice. Apart from the fact that each radiation burden of the population should be as small as possible, the measures necessary in an emergency must be based on a realistic examination of the risks. It should be the object of emergency planning at nuclear power plants to specify the required efficiency of rapid methods for monitoring accidentally released radionuclides. (auth)

28057 FIRST MEASURES FOR ASCERTAINING RADIATION DANGER IN THE NEIGHBORHOOD OF THE FEDERAL INSTITUTE FOR REACTOR RESEARCH (EIR) AFTER AN ACCIDENT. Nagel, E. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). pp 695-703 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

On the strength of safety analyses, hardly any immediate danger exists for the population in the neighborhood of the EIR in the event of a reactor incident; although local restrictions may be a possibility (milk-monitoring, ban on grazing), the need for evacuation will hardly arise. Moreover, the area affected will be limited in size (some 10 km^2). There will in any case be several hours for determining the actual situation. In an emergency the amount and kind of radioactivity released and the extent of contamination of the surrounding area must be determined. Activated charcoal filters (especially for ^{131}I monitoring), dust filters (for aerosol monitoring) and gamma monitoring (rare gases) are used for monitoring the sources. The collection of samples from the surroundings (according to weather and dispersion conditions) is performed by existing routine collecting stations (vaseline-coated plates for collecting dust, gamma dosimeters, water samples) and by additional sampling (dust from air, grass). This is carried out without regard to maximum efficiency. No analyses are made in the field. For the laboratory analyses, rapid counting methods (gamma spectrometry, beta energy determination, alpha activity) and chemical methods are employed, and the most important isotope present, in particular ^{131}I, is identified, taking into account short-lived elements which may mask the presence of other important isotopes. Determination of the dispersion of contamination is done on the basis of measurements and samples taken along routes selected beforehand according to prevailing weather conditions. These operations may last several hours. If the situation demands further, possibly restrictive measures, appropriate outside authorities are notified by the central administration of the EIR emergency organization. (auth)

28058 CONTINGENCY RESPONSE FOR RAPID EVALUATION OF RADIOLOGICAL POLLUTION FROM A SPACE VEHICLE LAUNCH ACCIDENT. Shearin, R. L.; Phillips, C. R. (Eastern Environmental Radiation Lab., Montgomery, Ala.). pp 757-67 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

In fulfilling the Environmental Protection Agency's responsibility for providing surveillance and evaluation of environmental pollution, the Agency's Eastern Environmental Radiation Laboratory provides a contingency response capability in support of certain space vehicle launch operations. The plan described provides for the rapid evaluation of environmental elements in the public domain adjacent to space launch facilities. The plan is implemented during the final phase of launch operations of space vehicles carrying SNAP-27 devices which contain a significant quantity of ^{238}Pu. Teams are deployed to intercept a computer-predicted fallout pattern along available access roads and according to the distribution of the population. Such deployment is complicated by the presence of 750,000 people observing the launch from the roadsides, thereby clogging major traffic routes during the final countdown phases. Monitoring equipment includes FIDLER detectors and appropriate equipment to determine airborne and surface contamination. Radio communications provide a centralized control room with data from on-site, off-site and airborne monitoring units for evaluation. The accumulated data are interpreted by a team of experts who review the entire radiological picture and then make recommendations to the pertinent authorities for necessary action. Although several agencies work together to fulfill numerous responsibilities, the system has operated smoothly in the support of Apollo 12, 13, and 14. The success of the system is dependent upon the co-operation between the many agencies involved such as the Atomic Energy Commission, National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, the Environmental Protection Agency, and State and local health officials. (auth)

28059 RAPID ENVIRONMENTAL MONITORING IN NUCLEAR EMERGENCY SITUATIONS. Frittelli, L. (CNEN, Rome). pp 769-77 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

The planning of fast environmental monitoring in emergency situations in the neighborhood of a nuclear plant described here is based on a preliminary survey, to obtain with physical field methods only a fast assessment of the likely population exposure and of the possibility for remedial action. On a follow-up survey a more detailed assessment of the dispersion of the released radionuclides in the environment would be obtained through laboratory analysis of environmental samples. (auth)

28060 EVALUATION OF ENVIRONMENTAL MONITORING DATA FOR NUCLEAR FACILITIES. Marley, W. G. (National Radiological Protection Board, Harwell, Eng.). pp 799-808 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

Environmental monitoring data, obtained under normal operating conditions, must be evaluated by comparison with derived working limits (DWL) related to the dose limits laid down by ICRP. Under emergency or accident conditions, the data must be evaluated by comparison with emergency reference levels (ERL) related to tissue doses considered acceptable in the particular circumstances. The procedure for evaluation of environmental data is reviewed and the nuclides likely to be of importance under emergency conditions for various types of reactor are identified. Values are suggested for ERLs of dose and of contamination by specific nuclides for evaluation of environmental monitoring data in particular circumstances under emergency conditions. The radiological risks associated with the tissue doses appropriate

to emergency conditions are discussed by reference to existing risk evaluations, and the potential risk following irradiation of the foetus, as a result of exposure of a sizeable population to whole-body gamma radiation, is estimated. (auth)

Atmosphere

Refer also to abstracts 27823 and 28497.

28061 (CXRL-5) CONCENTRATIONS OF RADIOACTIVE ISOTOPES IN AUSTRALIAN SURFACE AIR DURING THE PERIOD MAY 1965-MAY 1970. Bonnyman, J.; Duggleby, J. C.; Molina-Ramos, J. (Commonwealth X-Ray and Radium Lab., Melbourne (Australia)). 28p. Dep. NTIS (U. S. Sales Only).

Concentrations of ^{137}Cs, ^{144}Ce, ^{141}Ce, ^{89}Sr, ^{90}Sr and ^{210}Pb in surface air, measured in picocuries per thousand cubic meters are tabulated for Melbourne, Victoria (1965 to 1969), Brisbane and Townsville, Queensland (1966 to 1967), Sydney, New South Wales (1966 to 1969) and Perth, Western Australia (1966 to 1969). (Australia)

28062 (HASL-249, pp I,62-6) HASL SURFACE AIR SAMPLING PROGRAM: THE QUALITY OF THE RADIOCHEMICAL ANALYSES, 1970. Volchok, Herbert L. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Apr 1972.

In Fallout program quarterly summary report, December 1, 1971-March 1, 1972.

In general the quality of the radiochemical analyses in the Surface Air Sampling Program in 1970 was acceptable. The lowest levels encountered for stable lead and ^{238}Pu approach the blank and at these levels, the data are therefore inaccurate. (auth)

28063 (HASL-249, pp II,1-182) HASL FALLOUT PROGRAM DATA. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Apr 1972.

In Fallout program quarterly summary report, December 1, 1971-March 1, 1972.

HASL data on the following subjects are summarized: ^{90}Sr content of diets in New York City and San Francisco during July through December 1971; measurements of the gamma radioactivity and radioisotope content of samples from the lower stratosphere over the western hemisphere during February, May, July, and October 1971; and the high-altitude balloon sampling program conducted during 1970 and 1971 for measuring fallout in the stratosphere over stations in Texas, Australia, and the Canal Zone. (L.C.L.)

28064 (HASL-249(App.)) APPENDIX TO FALLOUT PROGRAM QUARTERLY SUMMARY REPORT, DECEMBER 1, 1971-MARCH 1, 1972. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Apr 1972. 431p. Dep. NTIS.

Tabulated data from the HASL fallout monitoring program are presented and include information on the ^{89}Sr and ^{90}Sr deposition at 125 world land sites, ^{90}Sr deposition at Atlantic Ocean weather stations, ^{90}Sr content in New York City milk and tapwater, and gamma radioactivity, radioisotope content, and stable lead content of surface air at world land sites. (L.C.L.)

28065 (JUL-807-ST) ANNUAL REPORT JULY 1970-JUNE 1971. SPREADING AND DEPOSITION. Vogt, K. J.; Heinemann, K.; Nordsieck, H.; Polster, G.; Rohloff, F.; Angeletti, L. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). Aug 1971. 144p. (In German). Dep. NTIS (U. S. Sales Only).

The spreading and deposition of radioactive material were studied using radioactive copper aerosols. The instrumentation, experimentation, and data evaluation are described. Results show that because of increased turbulence, maximal concentrations close to the soil level lie closer to the source than expected from calculations with Pasquill's parameters. This tendency is confirmed by turbulence measurements. The natural iodine content was determined in soil, grass, air, and filter material. Preliminary results show that the fallout constant of iodine on grass and other test surfaces possesses a complex dependency on iodine concentration, duration of emission, and duration of adhesion. (H.B.G.)

28066 ESTIMATE OF VOLCANIC CONTRIBUTIONS TO THE ATMOSPHERE AND VOLCANIC GASES AND SUBLIMATES AS THE SOURCE OF THE RADIOISOTOPES ^{10}Be, ^{35}S, ^{32}P, AND ^{22}Na. Bartels, Otto G. Health Phys.; 22: No. 4, 387-92(Apr 1972).

Utilizing data on the presence of a sulfate aerosol layer in the stratosphere, an analysis is made of the source of excess sulfate in precipitation. Data are presented against the hypothesis of appreciable escape to the atmosphere of H_2S produced on the continental shelves. Calculated volcanic contributions (in metric tons/y) to the atmosphere were: chlorine-7.6×10^6, sodium-6.0×10^6, sulfur-1.7×10^7, fluorine-7.3×10^5, boron-7.3×10^4, potassium-2.3×10^6, and calcium-7.2×10^6. The calculations support Conway's hypothesis of volcanic water and the volcanic chloride origin of the ocean. The points of weakness in the spallation hypothesis of atmospheric radioisotopes are presented. A table with the probable nuclear particle abundance at 16 km altitude is given. Calculations are made of the relative concentrations of boron, chlorine, sulfur and fluorine in the upper atmosphere. The results almost parallel the abundance values in igneous rocks. Data on the probable altitudes where the nuclear reactions occur are presented, including a new source for the sodium lines in the upper atmosphere air glow. (auth)

28067 SPECIFIC β-RADIOACTIVITY OF THE RAIN IN THE DEPARTMENT OF KATOWICE. Kwapulinski, Jerzy. Acta Geophys. Pol.; 19: No. 4, 379-90(1971). (In Polish).

The systematic investigation of the β-radioactivity of rain performed in Wapienica and Kozlowa Góra permitted the following conclusions: The β-radioactivity of rain studied over a long period of time undergoes considerable change; in regions characterized by greater dustiness of the air, the statistical average β-radioactivity is smaller than in those with lower dustiness (growth of the specific β-radioactivity was observed in Wapienica); the specific β-radioactivity of rain in Wapienica and Kozlowa Gora was estimated to be in the range from 100 to 500 pCi/g. The other, higher values observed indicated the temporarily greater contamination of the air in these regions; and the distribution of the frequency of appearance of individual values of β-radioactivity of rain was logarithmic. (auth)

28068 MEASUREMENTS OF ^{90}Sr, ^{137}Cs, ^{144}Ce, ^{147}Pm, ^{155}Eu, ^{95}Zr, AND ^{106}Ru IN MONTHLY FALLOUT SAMPLES COLLECTED AT SEGRATE (MILAN). Albini, A.; Battaglia, A.; Quaini, L.; Triulzi, C. (CISE, Milan). Energ. Nucl. (Milan); 19: No. 4, 257-62(Apr 1972). (In Italian).

From 1961, radioactivity measurements on fallout samples were performed at CISE (Centro Informazioni Studi Esperienze); such samples were collected within Center's area, located near Segrate about 3 miles east Milan. Collections were carried out monthly and, after nuclear atmospheric tests, weekly. After beta radioactivity and direct gamma measurements, such samples were analyzed by suitable radiochemical separations to determine several radionuclides of interest. The results are reported concerning ^{90}Sr, ^{137}Cs, ^{144}Ce, ^{147}Pm, ^{155}Eu, ^{95}Zr, and ^{106}Ru content in samples collected from November 1968 to June 1971. In addition, the main steps of the radiochemical methods employed are reported. (auth)

28069 IN SITU EXTERNAL ENVIRONMENTAL GAMMA-RAY MEASUREMENTS UTILIZING Ge(Li) AND NaI(Tl) SPECTROMETRY AND PRESSURIZED IONIZATION CHAMBERS. Beck, H. L.; Lowder, W. M.; McLaughlin, J. E. (Atomic Energy Commission, New York). pp 499-513 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

The Health and Safety Laboratory first used in situ NaI(Tl) spectrometry in conjunction with pressurized ionization chambers in 1962 to estimate individual exposure rates from each of the major natural and world-wide weapons fall-out emitters distributed in the soil. Hundreds of measurements were made throughout the continental United States of America, as well as on Bikini Atoll in the South Pacific. In addition, other investigators have utilized these techniques or similar ones to characterize gamma radiation fields in other areas of the world. Recently there has been increasing interest in estimating exposure rates from trace quantities in the environment of artificial isotopes emitted from nuclear power plants and reprocessing facilities. The gamma rays from these sources are usually of such low intensity and energy that they cannot be resolved adequately by utilizing NaI(Tl) spectrometry. Therefore, direct in situ measurements in the field were attempted with a large Ge(Li) diode to take advantage of the vastly superior energy resolution of this type of detector. With analytical techniques similar to those utilized in interpreting the NaI(Tl) field spectra, these in situ Ge(Li) measurements demonstrate that it is not only possible to estimate exposure rates from trace amounts of such isotopes as ^{131}I in the soil, but in many cases one can more accurately estimate natural emitter and individual world-wide fall-out emitter exposure rates than was possible with NaI(Tl). NaI(Tl) field spectrometric technique and its extension to in situ Ge(Li) spectrometry is reviewed. Actual field measurements at both operating nuclear facilities and back-

ground locations are discussed, with special reference to the utility of Ge(Li) field spectrometry for characterizing an external environmental gamma radiation field. (auth)

28070 STUDY OF THE FEASIBILITY OF MEASURING ^{85}Kr THROUGH A NATIONAL SURVEILLANCE SYSTEM. Shearin, R. L.; Porter, C. R.; Cummings, S. L. (Eastern Environmental Radiation Lab., Montgomery, Ala.). pp 649-53 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

In support of the Environmental Protection Agency's mission of evaluating environmental insult, the Agency's Eastern Environmental Radiation Laboratory has begun to evaluate the feasibility of determining the rate of increase of ^{85}Kr in environmental air caused by the discharge of the gaseous waste product from nuclear facilities. Compressed air is acquired from commercial suppliers in widely distributed locations throughout the United States of America. Krypton is separated from the air and counted by liquid scintillation. Comparison is made with previous determinations and predictions. Concentration versus time relations are presented to show any increased levels as more nuclear facilities go into operation. Sampling locations are selected to allow comparison between areas near operating facilities and unaffected areas. The results are analyzed to determine if statistically significant differences in levels exist between sampling locations. Variations and concentrations at a given location are also evaluated. Public exposure doses are calculated so as to demonstrate a correlated significance with other environmental radiation dose sources. Comments are offered relative to the future significance of ^{85}Kr in environmental radiation with projected growth in the nuclear industry. Based on the above study, the feasibility of operating a national network is presented, including recommended number of stations, mode of sampling, and sampling site selection. (auth)

28071 SIMPLE SYSTEM FOR THE RAPID DETERMINATION OF AIRBORNE RADIOACTIVITY. Garland, P. J.; Lovett, M. B.; Wilson, R. B. (Ministry of Agriculture, Fisheries, and Food, London). pp 723-36 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

In the United Kingdom environmental monitoring in relation to airborne discharges has revealed that usually no detectable contamination of the environment results from the normal operation of nuclear establishments. Even where detectable contamination does occur, the levels are almost always trivial. The use of sophisticated and elaborate monitoring programs is clearly not justified in these circumstances, and the operation of a simple indicator system capable of detecting both gaseous and particulate radioactive emissions is described. Although intended for the detection of the small amounts of radioactivity discharged to atmosphere during normal operation of nuclear establishments, the simplicity of design and ease of radioactivity measurement on the unprocessed detector make this an ideal indicating device for larger accidental atmospheric releases, and with a knowledge of the meteorological conditions the instrument can be used as a semi-quantitative measuring device. (auth)

28072 RAPID DETECTION OF AN ACCIDENTAL DISCHARGE OF RADIOACTIVE MATERIAL TO THE ATMOSPHERE. Palmer, G. H.; Johns, T. F.; Perry, K. E. G. (United Kingdom Atomic Energy Authority Research Establishment, Winfrith, Eng.). pp 737-44 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

An installation is described which is located some distance away from the reactor buildings and which can detect the passage of a cloud of radioactive gas. The detecting system responds to radiation dose rate and also allows the integrated dose to be measured, thus ensuring an alerting action even if the discharge takes the form of a short duration concentrated pulse of radioactive material. The rapid response of the system would give maximum time for the more urgent requirements for safeguarding people and initiating the follow-up district monitoring arrangements for establishing the extent of any ground contamination. (auth)

28073 RADIOACTIVITY OF THE AIR OF BUILDINGS IN TASHKENT. Shem'i-zade, A. E. (Tashkent State Univ.). Gig. Sanit.; No. 5, 111-13(May 1971). (In Russian).

Radioactivity of the air in buildings of different types in the city of Tashkent was measured both as Rn daughter products and nuclear fission products. Natural radioactivity was different in buildings of different types, e.g., the number of stories; fission products, however, exhibited the same activity level regardless of the building type, amount of ventilation, etc. (K.S.W.)

Soil

28074 (CLOR-87/D) NATURAL GAMMA BACKGROUND RADIATION MEASUREMENTS IN POLAND BY MEANS OF THE SCINTILLATION AIRPLANE MONITOR. Pensko, J.; Biernacka, M.; Gwiazdowski, B.; Niedziolka, E.; Mamont-Ciesla, K. (Centraline Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1971. 34p. (In Polish). Dep. NTIS (U. S. Sales Only).

The method and results of measuring natural gamma background radiation by means of a scintillation airplane monitor in some regions of Poland are described. The monitor was installed in the AN-2 airplane. The accuracy of the measurements in static conditions is of the order of ±15%. The exposure dose-rate was determined for the earth level in a net of points at 2 km distance of each other. The dose-rate values obtained for Kotlina Klodzka are within 6 to 16 μR/h. The vicinity of granite gneisses near Klodzko and the granites near Kudowa Zdrój are most probably responsible for the increase of the level of natural gamma background in this region. The average dose-rates in Kotlina Kowarska are within 12 to 16 μR/h but over the old dumps containing uranium they are up to 50 μR/h. Dose-rate values of the same order were found in the areas of paleozoic granites metamorphized into granite gneisses. Smaller values were found in the region of Wroclaw, and over Jezioro Otmuchowskie a specific decrease of the dose-rate to 2 μR/h was measured. The dose-rate values over the areas: Szwajcaria Kaszubska, Zulawy and Zatoka Pucka were found within 2 to 12 μR/h on the average being from 4 to 8 μR/h, but they were higher in the region of Wisla basin. The dose-rate values for the east part of Warszawa District were found within 4 to 14 μR/h, on the average being 8 to 10 μR/h, with the specific high value over the IBJ-Swierk reactor up to 50 μR/h. In the area of Kraków and Katowice Districts the dose-rate distribution was quite complicated and the dose-rate values were within 4 to 16 μR/h. The highest value was measured over Wyżyna Krakowsko-Czestochowska, along Wisla River, and in the south part of Kraków District over Pogórze Wielickie and over Rybnicki Okreg Weglowy. (auth)

28075 (HASL-249, pp I,67-94) PLUTONIUM ISOTOPIC RATIOS AT ROCKY FLATS. Krey, P. W.; Krajewski, B. T. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Apr 1972.

In Fallout program quarterly summary report, December 1, 1971-March 1, 1972.

Mass spectroscopic analysis of plutonium recovered from soil around Rocket Flats permits the quantification of low levels of plant plutonium superimposed on plutonium from global fallout. At 18 and 32 km east of Rocky Flats, plant plutonium is present at 0.89 and 0.15 mCi/km^2 deposition concentrations which are 60 and 10% of the global value, respectively. A new method of inventorying was developed which essentially reproduced an earlier inventory within the 3 mCi/km^2 contour but which reduced the burden beyond this contour to ½ the earlier estimate. (auth)

28076 SOME RESULTS OF AN INVESTIGATION OF THE RELATIONSHIP OF NATURAL RADIOACTIVITY AND ASH CONTENT OF COALS OF THE VORKUTSK FIELD. Gipsh, A. A.; Kapaturin, G. G. Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; No. 10, 145-9(1970). (In Russian).

An investigation conducted on the Vorkutsk coal field shows that there is a linear relationship between ash content of coals and their natural radioactivity. The radioactive elements in these coals are mainly in their mineral part. The content of radioactive elements in the Vorkutsk coals varies from area to area in the basin, with a general tendency to increase from northwest to southeast. (Geophys. Abstr.)

Water

Refer also to abstracts 27815 and 27855.

28077 (HASL-249, pp I,2-11) NATURAL CESIUM IN SEAWATER. Folsom, T. R.; Hansen, N. (Scripps Institution of Oceanography, La Jolla, Calif. Soledad Lab.); Robertson, D. E. (Battelle Pacific Northwest Labs., Richland, Wash.). 1 Apr 1972.

In Fallout program quarterly summary report, December 1, 1971-March 1, 1972.

In order to determine the amount and distribution of fallout Cs in oceans it is necessary to know the distribution of natural cesium. The equipment and methods developed at the Scripps Institution of Oceanography (SIO) and Battelle Northwest Laboratory (BNL) for analyzing seawater for natural cesium content are discussed and data from Cs analysis by flame photometry at SIO and by activation analysis at BNL are compared. Results with samples from the eastern north Pacific Ocean indicate that natural Cs content varies little with ocean depth and has an absolute concentration value of about 295 mg/l. (L.C.L.)

28078 (USGS-474-117) RADIOCHEMICAL ANALYSES OF GROUND-WATER SAMPLES COLLECTED AFTER THE SALMON EVENT IN THE VICINITY OF TATUM SALT DOME, LAMAR COUNTY, MISSISSIPPI. Dribble-47. Janzer, V. J.; Robinson, B. P.; Rucker, S. J. (Geological Survey, Denver, Colo.). 1971. Contract AT(29-2)-474. 87p. Dep. NTIS.

Date written: 1965.

Ground-water samples were collected after the Salmon Event by the U.S. Geological Survey in the vicinity of Tatum salt dome, Mississippi, the U.S. Atomic Energy Commission Project Dribble Test Site. None of the 79 samples analyzed by the U.S. Geological Survey as part of the post-Salmon Event evaluation program show any evidence of increased background levels of radioactivity. (auth)

28079 ROLE OF FRESHWATER VEGETATION DURING THE MIGRATION AND DISTRIBUTION OF NATURAL RADIOACTIVE ELEMENTS IN A RESERVOIR. Iskra, A. A.; Kulikov, N. V.; Bakhurov, V. G. Ekologiva; No. 2, 83-9(1970). (In Russian).

The accumulation of ^{238}U, ^{226}Ra, and ^{232}Th in 27 species of freshwater plants was studied under experimental conditions. The most complete purification of the medium was found in the water-soil-plant system. The accumulation of U and Th was in plants and detritus, respectively, while Ra was distributed uniformly in the components of the system. (Euratom)

28080 CONTAMINATION OF THE SEAS AND OCEANS BY ARTIFICIAL RADIOACTIVITY. Preston, A. (Ministry of Agriculture, Fisheries and Food, Lowestoft, Eng.). Underwater J.; 4: No. 2, 49-58(Apr 1972).

The problems associated with artificial radioactivity as a contaminant of the seas and oceans are discussed against a historical background, and projections are made as to future levels of contamination. The procedures evolved for the control of deliberate introductions of radioactive waste material are discussed in detail, and the requirements for monitoring are considered. It is concluded that the control of artificial radioactivity, associated with waste disposal, has been exemplary and that, provided current procedures for control are observed, international surveillance can be restricted to the compilation of a register of disposals. (auth)

28081 AUTOMATIC MONITORING METHOD USING BIOLOGICAL CONCENTRATION FOR MARINE RADIOACTIVE CONTAMINATION. Hiyama, Y. (Tokyo Univ.); Shimizu, M.; Kuwabara, R.; Yamamoto, T. pp 627-34 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

For the continuous automatic monitoring of radioactivity in coastal water, a scintillation counter in a waterproof container dipped in water is a possible method. A new and efficient device with a crown or cap containing certain organisms at the top of the waterproof counter head has some advantages, and is described. As the organisms located close to the counter head concentrate the radionuclides from seawater up to an equilibrium level, a larger amount of radiation is in contact with the scintillation counter head than from the seawater directly. The level of detection by this device equipped with the organism crown is about 10^{-1} to 10^{-2} above that without the crown. The level of concentration of the radionuclides in the indicative organisms is nearly proportional to that of the edible marine organisms under consideration, if a reliable ratio of the concentration factors of the radionuclides concerned is obtained between the indicative and the edible. Even while the fluctuation of the level of the contamination is large and frequent, for example when small amounts of radioactive waste are frequently discharged, the level of this counter recording or indication is quite smooth and the wave is flatter, because the biological intake and excretion of the radionuclide takes place over a period of time, although it differs according to the size and species. However, as this is a continuous automatic survey, if the level goes above a certain level set previously, an alarm system will work, even in the case of an accidental release. Frequent chemical or physical analyses require time and money, but with this method analysis is required only after the alarm is given or at the end of a survey of organisms and seawater. Indicative organisms should be selected from a species with a wide distribution among the plants and animals of the tidal zone. Only beta and gamma radiation can be detected. If it is difficult to trace the single radionuclide of major concern or more than one radionuclide is taken up by the organism, this method has disadvantages. Some experiments with mussels and algae are reported here. Further investigations with other organisms and nonbiological material, such as ion exchange resin, are being undertaken. (auth)

28082 RADIOACTIVE AND METALLIC (COPPER AND ZINC) POLLUTANTS IN THE SCHELDT ESTUARY (IN WATER, SEDIMENT, AND SUSPENDED MATTER). Peeters, Elisabeth; Henry, Michele-France; Castiaux, Marie-Anne (Institut Royal des Sciences Naturelles de Belgique, Brussels). pp 635-47 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In French).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

As part of a study of fresh-water and seawater pollutants and their influence on the ecology of the Belgian coast, a general investigation of the various radioactive and metallic pollutants present in sediment, water and suspended matter in the North Sea and the Scheldt Estuary was begun. All the radioactive pollutants in a given part of the Scheldt are being subjected to a thorough study. The metallic pollutants include copper and zinc, for which a fast determination method is being developed. The radionuclides are being determined by high-resolution gamma spectrometry, and copper and zinc by atomic absorption spectrophotometry. A similar method is to be employed later for determining mercury and lead in the same matrices. (auth)

28083 POLLUTION OF THE WORLD OCEANS. Patin, S. A. (All-Union Scientific Research Inst. of Marine Fishing Industry and Oceanography, Moscow). Ryb. Khoz.; No. 5, 5-7(1971). (In Russian).

World ocean pollution by chemicals, particularly petroleum products, heavy metals, pesticides, and chemical plant wastes and contamination by radioactive fallout and sea-disposed radioactive wastes are discussed, and the urgency of expediting national and international progress for solving the problems of world ocean pollution is emphasized. (L.C.L.)

Ecosystems and Food Cycles

Refer also to abstracts 27802, 28427, 28440, 28520, 28522, 28529, and 28531.

28084 (HASL-249, pp I,95-105) ^{90}Sr IN THE DIET: RESULTS THROUGH 1971. Bennett, B. G. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Apr 1972.

In Fallout program quarterly summary report, December 1, 1971-March 1, 1972.

Estimates of ^{90}Sr intake via the total diet in New York City and San Francisco have been made since 1960 from quarterly food samplings and average consumption statistics. The dietary intakes of ^{90}Sr have decreased from the maximum levels attained during 1963 to 64, but the declines have become more gradual in recent years due to the continuing small amounts of ^{90}Sr deposition and the little changing cumulative deposit of ^{90}Sr in soil. The annual intake in 1971 averaged 12.8 pCi/day in New York, a slight increase from the previous year, and 4.0 pCi/day in San Francisco, a slight decrease from 1970. Further gradual reductions in ^{90}Sr intake are anticipated during 1972. (auth)

28085 RADIOACTIVE MILK CONTAMINATION IN POLAND IN 1966. Jankowska, Silia; Zajac, W. Rocz. Inst. Przem. Mlecz.; 11: No. 5, 39-54(1970). (In Polish).

Average yearly values (pCi/l) for the contamination of worldwide and Polish milk supplies were found to be: total β activity, 1155 to 1368 and 1288, ^{40}K 1003 to 1141 and 1084, ^{137}Cs 17.9 to 218.4 and 58.0, and ^{90}Sr 6.6 to 37.8 and 13.4. The ^{137}Cs to ^{90}Sr ratio in Poland averaged 4.0 and ranged from 2.6 to 4.7. Both ^{137}Cs and ^{90}Sr decreased in comparison with previous years; there were seasonal changes in milk contamination and no abrupt increase after the start of pasture feeding. (Euratom)

28086 PRESENCE AND DISTRIBUTION OF FALLOUT ^{90}Sr IN MARINE FAUNA. Mascia, Carlo; Capone, W. (Univ.,

Cagliari, Italy). Rend. Semin. Fac. Sci. Univ., Cagliari; 39: No. 3-4, 445-9(1969). (In Italian).

High concentrations of ^{90}Sr were detected in plankton collected from the Gulf of Caglieri at various times in 1969, while holothuria collected from the same region showed low concentrations. Sardines (Clupea pilchardus) collected at various times in 1968 showed high concentrations of ^{90}Sr, particularly those obtained in May and June. The highest flesh concentrations of ^{90}Sr was found in the posterior zone of the body. When considering the entire fish, however, the ^{90}Sr concentrations were generally highest in the vertebral column. Since the sardine consumes large quantities of plankton and is also used as food for humans, it is possible for man to ingest appreciable amounts of ^{90}Sr from the sea. Thus, the nonuniform distribution of ^{90}Sr in marine fauna was confirmed, as was the selective deposition of ^{90}Sr in the skeleton of the sardine. (Euratom)

28087 DETERMINATION OF MOVEMENT AND IDENTITY OF STOCKS OF COHO SALMON IN THE OCEAN USING THE RADIONUCLIDE ^{65}Zn. Loeffel, Robert E. (Fish Commission of Oregon, Clackamas); Forster, William O. Res. Rep. Fish Comm. Oreg.; 2: No. 1, 1-13(Dec 1970). (RLO-1750-87).

The radioisotope, ^{65}Zn, which occurs in the Columbia River plume because of the Atomic Energy Commission operations at Hanford on the Columbia River, is assimilated by coho and if retained long enough biologically has a sufficient half life (245 days) to serve as a natural mark for coho. Zinc-65 was studied as a marker by comparing ^{65}Zn levels in coho taken along the British Columbia-S.E. Alaska coast during the summer months north of the Columbia River plume, and in the suspected migratory path for Oregon-Washington coho during their first few months in the ocean. Bering Sea coho were included to provide a measure of ^{65}Zn that was not of Hanford origin. Samples were collected by the University of Washington Fisheries Research Institute and were passed on to the Oregon State University Department of Oceanography for radioanalysis. Variation in activity between coho collected in time-space subdivisions within each year was observed. The variation was taken as evidence that coho originating from streams south of the area of collection were in the sample as well as coho from British Columbia and S.E. Alaska. The levels of activity appeared to be high enough that if coho so marked were caught 6 months later on the high seas they would be distinguishable from unmarked coho. Most fish contained some ^{65}Zn above background levels, which suggests that ^{65}Zn is carried farther north than the plume appears to take it. The presence of fish with high levels of ^{65}Zn in the northern samples supports the thesis that a northward migration of Oregon-Washington juvenile coho occurs. (auth)

28088 FORECAST OF THE FUTURE ACTIVITY OF DEPOSITS OF ^{90}Sr AND ^{137}Cs IN MILK. Csupka, St.; Carach, J.; Petrasova, M.; Cechvala, L. (Hygiene-Epidemiology Inst., Bratislava). Z. Gesam. Hyg. Ihre Grenzgeb.; 17: 26-8(Jan 1971). (In German).

Using the values for milk previously obtained, the proportionality factors for the cumulative annual deposition of fallout were determined by regression equations. On the one hand the proportionality factors were determined by means of the cumulative deposit p_r 0.78 and p_d 0.07, and on the other hand by the ^{90}Sr-concentration and the ^{137}Cs-concentration in the soil, p_r 0.54 and p_d 0.11 for the ^{90}Sr; p_r 1.33 and p_d 0.02 for ^{137}Cs. By applying this factor, the future levels of ^{90}Sr and of ^{137}Cs in milk were calculated according to two presupposed models of future fallout. In the year 2000 a difference ranging up to 3-fold must be expected between these two models, with regard to the level of ^{90}Sr and ^{137}Cs in milk. (auth)

28089 PASSAGE OF ^{90}Sr FROM MILK TO MILK PRODUCTS DURING PROCESSING. Yashchenko, V. F. (Veterinary Inst., Leningrad). Gig. Sanit.; No. 5, 108-9(May 1971). (In Russian).

The ^{90}Sr content of milk was measured during processing to cream, skim milk, curds, and whey, and the content of stable Ca was determined for comparison. The liquid products (skim milk and whey) retained the bulk of both Sr and Ca; the ratio of $^{90}Sr/Ca$ was between 4.7 and 5.8 in milk and the four products. (K.S.W.)

28090 SAMPLING FOR RAPID ESTIMATION OF ^{137}Cs CONTAMINATION OF MEAT FROM HERBIVORES. Schauer, T.; Kreuzer, W.; Maurus, P. (Univ., Munich). pp 621-26 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

For an examination of the basic foodstuff meat, it is necessary to have an idea of the average and the maximum possible contamination of the meat of herbivores, since even in a small area significant fluctuations may occur. The reasons for this are due not so much to differences in precipitation contamination as to differences in local conditions (ecology) and in the plant composition of the fodder. Thus in areas with the same average precipitation, ^{137}Cs activity in lichens fluctuates by about 20%, whereas in plants used for fodder and grazing it fluctuates by up to 3000%. Reindeer moss (Cladonia rangiferina) has proved to be a good bioindicator for determining the kind and degree of precipitation contamination of an area, because it can store up large activities, particularly of ^{137}Cs, from precipitation, and is widespread in Europe. Type of soil, water economy, and type of cultivation are essential ecological factors in ^{137}Cs contamination of plants. Land cultivation and use, such as frequent mowing, grazing and fertilizing, has a strong influence on cesium uptake in plants. Plants from potassium-rich soils usually show only slight ^{137}Cs contamination, whereas plants from potassium-depleted fallow or acidic land show high contamination. The vegetation on wet, unfertilized soils, which are however rich in organic matter, such as low-lying moorland, acidic and fallow land, has therefore the highest ^{137}Cs contamination. (auth)

28091 FALLOUT RADIONUCLIDE DISTRIBUTION IN LICHEN COMMUNITIES NEAR THULE. Hanson, Wayne C. (Colorado State Univ., Fort Collins). Contracts AT(45-1)-1830; AT(11-1)-2122. Arctic; 24: No. 4, 269-76(Dec 1971).

Concentrations of the worldwide fallout radionuclides ^{54}Mn, ^{65}Zn, ^{90}Sr, ^{137}Cs, and Ce-^{144}Pr, and naturally-occurring ^{40}K were measured in 80 lichen species collected near Thule, Greenland, during July to Aug. 1968. Emphasis was placed on ^{138}Cs for detailed comparison of radionuclide distribution within the 6 major and 5 minor lichen communities of the 1,500 km^2 area studied. Mean ^{137}Cs concentrations in major lichen species ranged from 22 pCi/g standard dry weight in Stereocaulon paschale to 50 pCi/g in Cornicularia divergens, with an overall average of 33 pCi/g. Significant differences were noted between species, habitats and world regions. (auth)

28092 STATUS ON SOME HEALTH PHYSICS ASPECTS OF RADIO-IODINE. Tokyo; Nuclear Safety Research Association (1971). 110p. (In Japanese).

Of the radioisotopes released during a nuclear reactor accident, radioiodine is one of the most important from the viewpoint of health physics. Knowledge of the behavior of radioiodine has been obtained in laboratory scale experiments, but there is evidence that the results thus obtained can not be directly applied to its behavior in the natural environment. This study aims to fill the above mentioned gap, and establishes a method for evaluating the radiological hazard due to radioiodine in the natural environment, and protective countermeasures, in the case of actual accident, by carrying out experiments in the quasi-natural environmental state. Main subjects studied included: deposition of radioiodine in various chemical forms on the earth, pine tree leaves and some vegetables; and collection efficiency of sampling methods for radioiodine of various chemical forms under high humidity with time dependency. The apparatus and equipment used, experimental methods, and the results obtained are described. (auth) (Japan)

28093 PROBLEMS OF THE RADIOECOLOGY OF AQUEOUS ORGANISMS. Symposium Held at Miass, USSR, July 10-15, 1968. Shvarts, S. S. (ed.). Tr. Inst. Ekol. Rast. Zhivotn.; No. 78, 1-240(1971). (In Russian). (CONF-680735).

This volume contains 40 papers which are concerned with problems of fresh and marine water ecology, touching upon its biogeochemical, radiobiological, and health physics aspects. The accumulation, migration, and distribution of radioisotopes in water reservoirs and seawater, the effect of radioisotopes upon the hydrobiont, and the methodology of radioecological investigations are examined in various papers. The isotopes receiving particular attention include ^{141}Ce, ^{106}Ru, ^{65}Zn, ^{137}Cs, ^{90}Sr, ^{238}U, ^{210}Pb, ^{140}Ba-^{140}La, and ^{239}Pu. (K.S.W.)

Radiometric Techniques

Refer also to abstracts 27754, 27801, 27803, 28087, 28251, 28289, and 29707.

28094 DISTRIBUTION OF RADON IN A WELL. Davydov, Yu. V. Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; No. 5, 116-20(1970). (In Russian).

A solution is given to the problem of emanation logging of dry wells for the case of a complex law of distribution of radioactive

material in the ore layer. It is assumed that the diffusion properties of the active ore and surrounding rocks are the same. The distribution of emanation is found for the case of an ore layer of infinitely small thickness penetrated by a well of radius r_0. Then the ore layer is represented as a set of layers of infinitely small thickness, evenly distributed in an interval 2 h equal to the thickness of the formation. Then superposition of the solution for the infinitely thin layers gives the solution for a layer of finite thickness. Thus, this theoretical calculation of radon concentration in a well is attempted for conditions where the radioactive element content varies only through the thickness of the layer. (Geophys. Abstr.)

28095 TRANSPLUTONIUM NEUTRON ACTIVATION LOGGING TECHNIQUE. Tittman, Jay; Nelligan, William B.; Wahl, John S.; Sherman, Harold (to Schlumberger Tech. Corp.). U. S. Patent 3,654,467. 4 Apr 1972. Filed 12 May 1969.

A typical embodiment of the invention enables neutrons of low average energy that characteristically are emitted from ^{252}Cf to react with, or fail to react with, nuclei within an earth formation, depending on the energy threshold for the reaction in question. The neutron activation induced by means of the ^{252}Cf source is compared with the response induced in the formation through neutrons of higher average energies from other sources. The activation comparison permits the identification of elements and minerals in the formation to be determined accurately. (Official Gazette)

28096 SOME ASPECTS OF THE APPLICATION OF NUMERICAL METHODS IN WELL LOGGING PRACTICE. Plewa, Stanislaw (Instytut Naftowy, Krakow). Acta Geophys. Pol.; 19: No. 4, 423-33(1971). (In Polish).

Some problems concerning the recording of well logs, the conversion of logs from the analog to digital form, and the interpretation of results are discussed. A block diagram is presented of the Polish-designed analog code converter used in trial recordings of logs directly at the well-site. A section of well logs recorded in both analog and digital form is shown. The result of an interpretation of a set of logs—the gamma log (PG), the neutron-gamma log (PNG) and the gamma-gamma log (PGGg)—performed on an ODRA 1013 computer is presented. These logs were recorded in well B for the detection of brown coals. A chart indicates the interpretational steps required when determining the fractional water saturation of argillaceous sandstones in searches for oil and gas reservoirs. (auth)

28097 SCIENCE IN ARCHAEOLOGY, A SURVEY OF PROGRESS AND RESEARCH. Brothwell, D.; Higgs, E. (ed.). London; Thames and Hudson (1971). 720p. Two Pounds, Ninety-Five Pence.

The subject is dealt with in seven sections of which parts of one section entitled, Dating, is within scope. These parts are: radiocarbon dating; quaternary dating by the fission track technique; the potassium–argon dating of upper tertiary and pleistocene deposits; dating by the potassium–argon method—some advances in technique; and dating pottery by thermoluminescence. (UK)

28098 USE OF RADIOACTIVITY MEASUREMENTS IN STUDIES OF SEDIMENTARY ASSEMBLIES. Lucas, Claude (Univ., Toulouse). pp 223-8 of Proceedings of the 94th Congress of the Learned Societies. Vol. 2. Paris; Bibliotheque Nationale (1971). (In French).

From ninety-fourth national congress of the Learned Societies; Pau, France (8 Apr 1969). See CONF-690461-(Vol.2).

The sedimentary formations between the Garonne and the Adour were explored. The space distribution of the γ radiation intensity demonstrates the existence of an organization comparable to the lithologic successions. The results of these observations are compared with those obtained with other geological assemblies of the same type and age. In this way, details are revealed about the paleogeography which cannot be established by classical petrology methods. In the example studied, it is apparent that the intensity of the radiation is weaker in the lower series, assumed to belong to the Permian formation, than in the upper series assumed to belong to the Triasic formation. These results are contrary to those obtained for most of the other basins of similar age in France. A relation may exist between this fact and the nature of the lithologic landscape of the region. (France)

28099 STUDIES OF THE INFLUX OF STRATOSPHERIC AIR INTO THE LOWER TROPOSPHERE USING COSMIC-RAY PRODUCED RADIONUCLIDES AND FALLOUT. Reiter, R.; Sladkovic, R.; Poetzl, K.; Carnuth, W.; Kanter, H.-J. (Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung, Garmisch-Partenkirchen, Ger.). Contract AT(30-1)-4061. Arch. Meteorol., Geophys. Bioklimatol., Ser. A; 20: 211-46 (1971).

A procedure is outlined which permits continuous detailed study of the air mass exchange between stratosphere and troposphere. At the Zugspitze peak (2964 m above sea level) since Nov. 10, 1969, daily aerosol samples from 2000 m^3 each have been accumulated on membrane filters, over a period of 24 hours in each case. From these, the radionuclides ^{32}P and ^{7}Be and some fallout elements predominantly originating from the stratosphere, were chemically separated. Their concentration was determined by beta or gamma spectrometry. By comparing the variation of these values with time, against the development of the weather at tropopause level and inside the troposphere, it is possible, with the aid of coarse analysis, to draw conclusions as to the exchange processes between stratosphere and troposphere as well as the trajectories of the radioactive matter. Detailed results were obtained by means of isentropic trajectory analysis. The latter was based upon the radiosonde ascents of the area of the Atlantic Ocean and Europe. The performance of this fine analysis is demonstrated with an example. The results of this investigation were in good agreement with the results of others. The continuity of the daily measurements as well as the employment of computers permitted the quantitative determination and continuous observation of the air mass exchange between stratosphere and troposphere and the fine structure of the stratospheric-tropospheric exchange mechanism. (auth)

28100 U–Pb ISOTOPIC AGES OF ZIRCONS FROM PRECAMBRIAN ROCKS OF SOUTH GREENLAND. Chessex, R. (Univ., Geneva); Buchs, A.; Allaart, J. H.; (and others). Groenlands Geol. Unders. Rapp.; No. 42, 12p(1971).

Results of age determinations on zircons from samples of gneiss, granite, syenite and diorite from the Ketilidian mobile belt of South Greenland are presented. The lead isotopes were determined by a direct ionisation method. As three of the four zircon concentrates gave more or less discordant results, their interpretation is difficult. However, the data agree with the view that late Ketilidian granite emplacement took place roughly 1800 My ago and not around 1600 My age as the previously available K/Ar dates on pre-Gardar rocks seemed to indicate. (auth)

Site Surveys

Refer also to abstracts 28013 and 28115.

28101 (DOCKET-701201-1) COMMERCIAL NUCLEAR FUEL PLANT. Environmental Report, UF_6–UO_2 Pellet Plant Addition. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). 21 Feb 1972. 72p. (BAW-1375). Dep. NTIS.

The facility for the UF_6–UO_2 Pellet Production Plant will adjoin B&W's present power reactor fuel assembly plant. Included in the request for a major amendment to its special nuclear materials license for the operation of the Pellet Plant facility is a description of site and surrounding area, impact and effects of plant on environment, alternatives to proposed action, pollution monitoring systems for the UF_6–UO_2 Pellet Plant, environmental perspective—long-term productivity, irreversible and/or irretrievable commitment of resources, and relation of short- and long-term productivity and the environment. (P.C.H.)

28102 (DOCKET-701201-2) COMMERCIAL NUCLEAR FUEL PLANT. Submittal of February 18, 1972 Withdrawn. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). 16 Mar 1972. 1p. Dep. NTIS.

28103 (USGS-474-118) WATER LEVELS IN OBSERVATION WELLS IN THE TATUM SALT DOME AREA, 1961–65, LAMAR COUNTY, MISSISSIPPI. Dribble-48. Taylor, R. E. (Geological Survey, Denver, Colo.). 1971. Contract AT(29-2)-474. 28p. Dep. NTIS.

Date written: 1966.

Since 1961 the U.S. Geological Survey has monitored water levels in 26 wells in 8 aquifers in the Tatum salt dome area, Lamar County, Mississippi. Hydrographs included in this report depict water-level fluctuations during each well's observation period. Six of the eight aquifers are artesian and areal in extent; the salt dome interrupts two aquifers and part of another. The aquifer in the caprock limestone of the dome is artesian. The aquifer in the terrace deposit is of the water-table type. The water level in the Cook Mountain Limestone, the deepest artesian aquifer monitored, has risen because of offsite oil-field brine injection. Water levels in the overlying fresh-water artesian aquifers declined, mainly in response to industrial and municipal pumpage. The surficial aquifer has seasonal water-level fluctuations and since 1961 has had a net decline. The 5-kt Salmon Event had no measurable permanent effect on the water levels in the

aquifers. The detonation had an immediate effect on water levels in certain wells, depending on the distance of the well from the shot-point and on the relation of the position of the aquifers to the shot-point. Since the October 22, 1964 underground test, the pumping and sampling program initiated on the test-site wells has resulted in local water-level declines. (auth)

28104 (WASH-1507) PLUTONIUM RECOVERY FACILITY, ROCKY FLATS PLANT, COLORADO. Environmental Statement. (Atomic Energy Commission, Washington, D. C.). Jan 1972. 127p. Dep. NTIS.

The environmental statement concerns the design and construction of a new plutonium recovery facility at the present Rocky Flats Plant site. The new facility has provisions for treatment of all Pu contaminated wastes. Results of the analysis show that addition of the proposed new facility will not pose any significant adverse impact on the environment. (J.R.D.)

28105 GUIDELINES FOR DETERMINING THE OPERATING BASIS EARTHQUAKE AND ASSOCIATED VIBRATORY GROUND MOTION. ANS 2.1-1971. Hinsdale, Ill.; American Nuclear Society (1972). 10p.

This standard provides guidance for the seismological and geologic investigations and evaluations needed to determine the Operating Basis Earthquake (OBE) and associated vibratory ground motion at a nuclear power plant site. The OBE, and associated vibratory ground motion, is a condition which might reasonably be expected to occur during the operating life of a nuclear power plant. The nuclear plant is designed so that in the event of an OBE, those features of the plant necessary for continued operation remain functional. The geological and seismological factors that should be taken into account in determining the OBE and associated vibratory ground motion are set forth. Factors affecting the dynamic behavior of the material underlying the nuclear power plant site are stated to aid in evaluating soil response effects. Surface faulting, stability of the foundation or underlying materials, and earthquake-caused water waves, such as tsunami, are not within the scope of this standard. (L.C.L.)

Thermal Effluents

Refer also to abstracts 30235, 30249, 30297, 30301, 30305, 30306, 30328, 30338, and 30355.

28106 ATOMIC HEAT FOR GERMAN RIVERS. Loebsack, T. Pharm. Ztg.; No. 20, 714-15(1971). (In German).

Using the Wuergassen nuclear power plant as an example, some ambiguous problems of thermal pollution are discussed. (INIS)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 28677 and 29006.

General Detectors and Monitors

Refer also to abstracts 28264, 28344, 28724, 29475, and 30424.

28107 (AD-734398) EVALUATION OF PLASTIC SCINTILLANTS FOR USE IN HIGH-SENSITIVITY MEASUREMENTS OF LOW-ENERGY GAMMA OR X RAYS. Covell, David F.; Cordova, Herman I. (Naval Ordnance Lab., White Oak, Md.). 8 Nov 1971. 10p. (NOLTR-71-215). NTIS.

Evaluation and engineering data are presented regarding the applicability of plastic scintillators for low energy gamma and x-ray detection with special application to delayed-coincidence counting. (auth)

28108 (AD-734399) HIGH CURRENT, LOW IMPEDANCE ACCELERATORS. Final Report. Miller, A. R.; Adcock, D. R.; Markins, D.; White, R.; Kolb, A. C. (Maxwell Labs., Inc., San Diego, Calif.). 2 Dec 1971. Contract DASA01-70-C-0045. 79p. (MLI-111; DNA-2746-F). NTIS.

A low impedance high power pulsed electron beam accelerator utilizing a water dielectric coaxial pulse line has been developed. The electron pulse is initiated by the simultaneous triggering of four parallel, 2 MV, low inductance, gas insulated spark gap switches with a scatter of less than 2 ns. The electron beam pulse, produced in a 15 nH field emission diode, has a peak amplitude of 835 keV at 850 kA, a 1/e current risetime of 20 ns and a duration of 80 ns. The 1.5 ohm pulse line is directly charged from a fast Marx generator and is matched through the switches into a transfer section connected to the diode. This section has sufficient shunt capacity to suppress the prepulse associated with the charging pulse. The beam power and total energy are in good agreement with the calculated output. (auth) (USGRDR)

28109 (ANCR-1035) INSPECT: AN INTERACTIVE COMPUTER CODE FOR UNFOLDING NEUTRON SPECTRA FROM ACTIVATION MEASUREMENTS. Narum, R. E. (Aerojet Nuclear Co., Idaho Falls, Idaho). Feb 1972. Contract AT(10-1)-1375. 71p. Dep. NTIS.

A computer program which uses interactive graphics techniques for unfolding neutron spectra from activation measurements is described. The program allows the user to communicate with the program through an IBM-2250 graphics display unit attached to an IBM-360/75J computer. The user may use the interactive facility to manipulate libraries of foil activation cross section sets and monitor the iterative process used for unfolding a neutron spectrum using those sets. (auth)

28110 (BNL-tr-470) HADAMARD-TRANSFORM SCINTILLATION COUNTER. Soroko, L. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by S. J. Amoretty (Brookhaven National Upton, N. Y.), from report JINR-P13-5696. 19p. Dep. NTIS.

A binary coded array of scintillation detectors for low-background angular distribution measurements is described. The multiplex counter consists of a composite scintillator containing 2M-1 elements, two light pipes, and trays for optical contact. (W.H.K.)

28111 (CEA-N-1518) MEASUREMENT OF THE ENERGY SPECTRUM OF FISSION NEUTRONS. I. DETECTORS AND ASSOCIATED ELECTRONICS. Bertin, A.; Duigou, M.; Nierat, G. (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). 1 Dec 1971. 34p. (In French). Dep. NTIS (U. S. Sales Only).

The characteristics of the detectors used to measure the energy spectrum of fission neutrons (a fast fission chamber containing 14 g of ^{238}U and a neutron detector utilizing a neutron-γ discrimination and operating in a 100 keV to 20 MeV energy range) are presented. The electronics used in conjunction with the detectors is discussed. (France)

28112 (CEA-R-4289) METHOD OF MEASURING THE DIRECTIONAL AND ENERGY DISTRIBUTIONS OF A PARTICLE FLUX. Hyver, Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan 1972. 54p. (In French). Dep. NTIS (U. S. Sales Only).

A method of measuring the directional and energy distributions of photons or electrons in an irradiated medium using an external collimated detector is described. γ ray photons, which involve particularly delicate measurements, are the principal concern of this study. The experimental validity of the method proposed for these measurements is examined. It is concluded that the method is valid in many different energy domains, provided that the appropriate technical modifications are made. (auth)

28113 (CONF-710639) PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON CADMIUM TELLURIDE, A MATERIAL FOR GAMMA-RAY DETECTORS, JUNE 29-30, 1971 AT THE CENTRE DE RECHERCHES NUCLEAIRES, STRASBOURG (FRANCE). Siffert, P.; Cornet, A. (eds.) (Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Recherches Nucleaires). 513p.

Papers are presented under the general topics of preparation, general characterization, application to nuclear particle detectors, and detector properties of CdTe compared to other possible materials. Thirty-two papers are included. (W.H.K.)

28114 (CONF-720306-6) PROPORTIONAL COUNTER PHOTON CAMERA. Borkowski, C. J.; Kopp, M. K. (Oak Ridge National Lab., Tenn.). [1972]. 20p. Dep. NTIS.

From Scintillation and semiconductor counter symposium; Washington, D. C. (1 Mar 1972).

A gas-filled proportional counter camera that images photon-emitting sources was built and tested. This camera measures and displays the impact location of individual photons in an energy range between 1 and 150 keV and permits pulse-shape and energy discrimination for background reduction. Possible fields of applications for this camera include nuclear medicine, nuclear physics, x-ray diffraction, and related areas. The signal processing of the camera is based on further improvements and simplifications of the risetime method as applied to multiwire position-sensitive counters. Materials inside the counter were selected so that the camera can be used over long periods of time without purification of the counter gas. The sensitive area of the camera is 200 × 200 mm^2, and the size of each picture element is 1 × 1 mm^2; thus 40,000 picture elements are resolved. Counting rates of up to 20,000 photons/s do not appreciably affect the spatial resolution. The camera was tested only with low-energy photons (<30 keV) to determine the properties and applicability of the camera; however, by use of high-pressure (>10 atm) Xe counter gas, a useful detection efficiency (>30%) and good spatial resolution are expected for 150-keV photons. (12 figures) (auth)

28115 (EGG-1183-1457) AERIAL RADIOLOGICAL MEASURING SURVEYS (ARMS). SYSTEMS AND PROCEDURES EMPLOYED THROUGH FY69. Tech. Report No. L-967. Anderson, C. N.; Bundy, D. H.; Cleland, J. R.; Weissman, V. F. (EG and G, Inc., Las Vegas, Nev.). 5 Dec 1969. 49p. Dep. NTIS.

The ARMS instrumentation, ground support equipment, flight procedures, survey procedures, and data analysis are described. The basic detectors for gamma spectroscopy are NaI(Tl) scintillation detectors. The pulse height analysis system, gross-count system, positioning system, readout system, and power system are discussed. Optional equipment that may be carried for specific missions includes an ion chamber for exposure-rate conversion studies, a paper-tape reader for reading the gamma spectra back into the multichannel analyzer, a neutron detector, an air sampling system, and an aerial photography system. The survey procedures are grouped as background surveys, emergency surveys, effluent tracking, and special surveys. (W.H.K.)

28116 (EGG-1183-2257) TIME-RESOLVED ELECTRON SPECTROMETER MEASUREMENTS OF A HIGH-INTENSITY ELECTRON BURST. Stevens, Jack (EG and G, Inc., Goleta, Calif.). Oct 1970. 12p. Dep. NTIS.

An electron spectrometer has been designed, built, calibrated, and used to measure the time-resolved energy and current of a high-intensity burst of electrons and to obtain the electron spectrum. The bremsstrahlung spectrum produced when electrons impinge on an x-ray target was calculated, and it agreed very well with that measured in a separate experiment. The technique used results in a reliable and relatively low cost method for determining both electron and bremsstrahlung spectra from 15 MeV down to keV energies. (auth)

28117 (HPA-5) GUIDANCE ON THE TESTING OF RADIATION PROTECTION INSTRUMENTS USED IN THE MEASUREMENT OF γ, X AND β RAYS. (Hospital Physicists' Association, London (England). Radiation Protection Committee). Jul 1971. 7p. Dep. NTIS (U. S. Sales Only).

A scheme for the radiation testing of instruments used for the measurement of γ, x and β rays in medicine and dentistry, compatible with a proposed national scheme, is outlined. The national scheme will involve the maintenance of primary and a very limited number of secondary standards. Types of radiation tests, frequency of tests, and test procedures are given. (UK)

28118 (LA–4878) MEASUREMENTS OF FILTERED X-RAY SPECTRA. Lier, Douglas W.; Israel, Harvey I.; Storm, Ellery (Los Alamos Scientific Lab., N. Mex.). Mar 1972. Contract W-7405-eng-36. 37p. Dep. NTIS.

A compilation of measured x-ray spectra is presented for three x-ray tubes operating at potentials of 60 to 300 kV with various thicknesses of aluminum, copper, molybdenum, lead, and uranium filters. The measurements were made with silicon and germanium semiconductors, sodium iodide scintillators, and a xenon proportional counter. The attenuation coefficients computed from the measured spectra are compared with those from theory. Because of Compton scattering, the energy region in which measurement and calculation agree within 10% is limited to above $(1/6)\ E_0$ for the beryllium-windowed tube and above $(1/4)\ E_0$ for the more heavily filtered tubes. Agreement is also limited to below $(3/4)\ E_0$ because of counting statistics. (auth)

28119 (LA-DC–72-186) NEUTRON COINCIDENCE COUNTERS FOR NUCLEAR SAFEGUARDS APPLICATIONS. Foley, John E. (Los Alamos Scientific Lab., N. Mex.). [1970]. 10p. (CONF-720306–3). Dep. NTIS.

From Scintillation and semiconductor counter symposium; Washington, D. C. (1 Mar 1972).

Reliable, accurate and rapid nondestructive assay instrumentation is playing an increasingly important role in the practical implementation of nuclear material safeguards, inspection, and surveillance as well as in quality control and operational safety in all types of nuclear processing facilities. The neutron coincidence counting technique has been successfully demonstrated for nondestructive assay of samples containing Pu or U. The technique involves detecting neutrons from the spontaneous fission of ^{240}Pu and ^{238}U with polyethylene moderated neutron coincidence counters containing $^{3}He0$ or BF_3-filled detectors surrounding the sample to be assayed. The coincidence counting technique is necessary for reliable assay since total neutron count rate is dependent not only on the amount of Pu in the sample but also on the chemical composition. By using the coincidence counting technique it is possible to distinguish spontaneous fission neutrons from the randomly produced (α,n) neutrons. Thus coincidence counting provides a powerful method for rapid and accurate assay of Pu-bearing samples. Recently, the use of fast plastic scintillation detectors has significantly extended the range of usefulness of the coincidence counting technique to materials with extremely high (α,n) activities. (auth)

28120 (N–72-13354) FABRICATION AND EVALUATION OF LARGE-AREA ULTRASOFT X-RAY DETECTORS SUITABLE FOR SPACECRAFT APPLICATION. Final Report. Bowyer, S. (California Univ., Berkeley. Space Sciences Lab.). 1 Oct 1971. Contract NAS9-11024. 27p. (NASA-CR–115265). NTIS.

The modifications to the Houston/MSC design of the gas proportional counter flight electronics system are discussed. The following modifications are described: charge amplifier bandwidth improvements, power converter redesign, serial data output buffer, second differentiator, and risetime discriminator. In addition, the redesign of the stellar aspect camera is discussed along with developments in thin film fabrication. (STAR)

28121 (ORNL-TM–3739) MONTE CARLO CALCULATIONS OF THE RESPONSE FUNCTIONS OF BONNER BALL NEUTRON DETECTORS. Burgart, C. E.; Emmett, M. B. (Oak Ridge National Lab., Tenn.). 3 Apr 1972. 19p. Dep. NTIS.

Adjoint MORSE calculations were performed to verify the response functions of Bonner ball neutron detectors. Bare 3-in.- and 6-in.-diameter Bonner balls were considered. These calculations utilized 123-group cross sections with 30 groups of thermal upscatter and also 104-group cross sections with a single thermal group. The response function shapes are in good agreement and the magnitudes are within 10% of previously reported results. (auth)

28122 (RFP–1620) DUAL-RANGE ALPHA COUNTER FOR HEALTH PHYSICS OPERATIONS. Tyree, William H. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 25 Feb 1972. Contract AT(29-1)-1106. 5p. Dep. NTIS.

A mobile, transistorized two-range alpha particle counter is described. The unit has the capability of detecting alpha-particle radiation with two air-proportional detectors. Integrated circuits and discrete components used in the unit provide pulse amplification, normalization, and current drive to a rate meter and aural readout. The system provides a low-power, low-cost counter for use within a process area for more reliable radioactivity-contamination control. (auth)

28123 (RFP–1621) NEUTRON CRITICALITY DETECTION SYSTEM. Tyree, William H. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 21 Mar 1972. Contract AT(29-1)-1106. 16p. Dep. NTIS.

A neutron criticality alarm system has been built which has applications for detecting high levels of neutron radiation. The system incorporates a thermal neutron-alpha reaction in a lithium-6 foil to produce pulses in a surface-barrier detector, and also includes a counting and sampling setup for noise rejection. As compared to earlier systems having a single detector, the described unit requires confirmation from a second detector before activating a general building-evacuation alarm. The system operates from a common DC voltage for electronics and detector and with an integral battery supply for power outages. The complete detector has been designed with costs below $130.00, while providing medium counting speed capability. (auth)

28124 (SC-T–713083) METHOD OF MEASURING A FAST ATOM FLUX. Dzhurakulov, Kh.; Rakhimov, R. R.; Printseva, N. V. Translated by Patricia Newman (Sandia Labs., Albuquerque, N. Mex.), from Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; 12: No. 5, 77-8(1968). 4p. Dep. NTIS.

A low-inertia calorimetric method for detecting atom fluxes with energies of 300 eV and higher is briefly described. The method is based on open miniature thermistors with sensitivities from 10^{-6} to 10^{-7} W, operating temperature range from −70 to +150°C, ohmic impedance ~9,000 Ω at 20°C, and temperature coefficient −3.78%. (W.H.K.)

28125 (UCRL–70170(Rev.1)) PULSED NEUTRON DETECTION SYSTEM. Zurakowski, P. R.; Shapiro, E. G. (California Univ., Livermore. Lawrence Livermore Lab.). 17 Jun 1971. 29p. Dep. NTIS.

An instrument that has the capability of measuring, within specific limits, fast flux, slow flux, dose equivalent rate, and average energy has been developed for use with pulsed neutron sources. The neutron detector consists of a Geiger tube with silver foil wrapped tightly around it. The detector measures the beta decay of silver activated by neutrons. Three detector heads, two with polyethylene moderator and one without, are used to measure the neutron fast flux, slow flux, and dose equivalent rate. By comparing the readings taken with the fluxmeter heads with those taken with the dose equivalent remeter head, it is possible to measure average energy. A portable, battery-powered scaler-timer is used to count the activity of the silver foil. A variable gating circuit is included to ensure that none of the prompt gammas are counted during the neutron pulse. This completely self-contained instrument may be used several hundred feet from an accelerator, where power may not be available. (auth)

28126 (UCRL–73494) HIGH OPERATING TEMPERATURE LIMITATIONS FOR GERMANIUM DETECTORS. Armantrout, Guy A. (California Univ., Livermore. Lawrence Livermore Lab.). 16 Feb 1972. 12p. (CONF-720306–4). Dep. NTIS.

From Scintillation and semiconductor counter symposium; Washington, D. C. (1 Mar 1972).

The operation of germanium spectrometers at temperatures considerably in excess of 77°K (with attendant advantages in the cooling system) has been made possible with the advent of high purity germanium. The basic limitations on operating temperature are due to (1) increased trapping effects and (2) increased electronic noise. An extensive analysis has been made of temperature-dependent noise sources. The principal limitation is due to trap and band-to-band bulk-generated currents. Experimentally determined parameters for germanium indicate that the operation of larger-volume detectors at temperatures in excess of 200°K is feasible. Several high purity detectors (1 cm^3 and 14 cm^3 in volume) have already been operated satisfactorily in the 170 to 180°K range, considerably higher than the 130 to 140°K maximum range observed for Ge(Li) detectors. In all detectors tested thus far, the principal limitation has been due to trap-generated current, which indicates the possibility of further improvement. (auth)

28127 PREPARATION OF METHANE GAS FILLING FOR PROPORTIONAL ^{3}H AND ^{14}C COUNTERS. Povinec, P. (Comenius Univ., Bratislava). Radiochem. Radioanal. Lett.; 9: No. 2, 127-35(30 Jan 1972).

An apparatus for methane production using carbon dioxide, water, and zinc dust as reactants in the presence of a ruthenium catalyst is described. A molecular sieve trap is used for the rapid purification of methane. Total yields of methane of better than 98% have been obtained. (auth)

28128 LOW-ENERGY NUCLEAR RADIATION DETECTOR OF THE SEMICONDUCTOR TYPE. Kozlov, Stanislav Fedorovich. U. S. Patent 3,638,022. 25 Jan 1972. Priority date 31 Jan 1969, Russia.

A device for detecting low-energy nuclear radiations and nuclear radiations in corrosive (reactive) media with a detector on the basis of a diamond crystal plate with contacts formed at the opposite sides is described. One of these contacts disposed on the plate side adapted to be irradiated is made blocking in relation to charge carriers, while the opposite contact disposed on the plate side not adapted to be irradiated is made of a material capable of injecting charge carriers under the influence of an applied electric field, the blocking contact being made of metal carbides. (auth)

28129 COMPARISON OF METHODS FOR DETERMINING HIGH GAMMA-INTENSITIES. II. Pavlicsek, I.; Stenger, V.; Csueroes, M.; Lakosi, L.; Veres, A. (MTA Izotop Intezete, Budapest). Izotoptechnika; 14: No. 10, 466-78(Oct 1971). (In Hungarian).

After an account of photoactivation and silicon semiconductor measurements, a comparison of these methods with those of the ionization chamber, calorimetry, and chemical dosimetry, published in the first part of the paper, is made. (auth)

28130 GAMMA CAMERA TOMOGRAPHY. THEORY AND PRELIMINARY CLINICAL EXPERIENCE. Freedman, G. S. (Yale-New Haven School of Medicine, New Haven). Radiology; 102: No. 2, 365-9(Feb 1972).

Radionuclide tomography using a gamma camera, a digital computer, and a special collimator is described. Planes of interest parallel to the crystal are reconstructed by the computer at any depth and displayed on an oscilloscope. Preliminary clinical experience has demonstrated deep lesions not seen by conventional scanning methods. Its usefulness in determining organ and lesion volumes, single-view organ analysis, and transverse tomography is discussed. (auth)

28131 CHANNELTRON GAIN IN MAGNETIC FIELDS. Hahn, Yu Bong; Hebner, Robert E. Jr.; Kastelein, Daniel R.; Nygaard, Kaare J. (Univ. of Missouri, Rolla). Rev. Sci. Instrum.; 43: No.4, 695-6(Apr 1972).

The gain and total count rate of electron channel multipliers depend strongly on applied magnetic fields. Experimental results for Channeltrons operated in magnetic fields of up to 300 G are reported. It was found that the applied voltage must be increased to about 4000 V to maintain a sufficiently high gain. Slightly higher count rates are observed if the magnetic field is parallel to the plane of the Channeltron, as compared to perpendicular to that plane. (auth)

28132 METHODS FOR TESTING PHOTOMULTIPLIERS FOR SCINTILLATION COUNTING. Krall, H. R.; Persyk, D. E. New York; Institute of Electrical and Electronic Engineers (1971). 27p.

Tests and procedures for photomultipliers for scintillation and Cherenkov counting are described. These tests are used for determining the characteristics of the photomultiplier with respect to pulse height, spurious pulses, and pulse timing. The tests discussed here are supplementary to those covering the basic characteristics commonly requiring specification for photomultipliers. (8 figures) (R.W.R.)

28133 THEORIE UND PRAXIS DER HALBLEITERDETEKTOREN FUER KERNSTRAHLUNG. (Theory and Practice of Semiconductor Detectors for Nuclear Radiation). Bueker, Harald. Technische Physik in Einzeldarstellungen, Band 17. Berlin; Springer-Verlag (1971). 310p. $26.00.

Topics include types and properties of nuclear radiation, detection methods for nuclear radiation, the semiconductor detector, manufacturing of semiconductor detectors, low-noise electronics for use with semiconductor detectors, and the use of semiconductor detectors in research and technology. Extensive lists of references are included. (W.H.K.)

28134 DETERMINATION OF THE GEOMETRIC FACTORS AT REDUCTION OF THE BACKGROUND IN β-SCINTILLATION MEASUREMENTS OF LOW-LEVEL ACTIVITIES. Dimchev, T.; Bakalov, D. (Inst. of Physics, Sofia). Kernenergie; 14: No. 12, 386-94(Dec 1971).

The existing possibilities for determination of the geometric factors are analyzed with a view to a reduction of the background effect in measuring low-level β-activities with thin plastic polymeric scintillators connected into an anticoincidence circuit. Expressions for the geometric factors on which depend the probabilities of detecting the cosmic and ambient irradiation as a function of the radii of the scintillators and the distance between them are discussed. The influence of the geometric parameters on the sensitivity of the method of measuring low-level β-activities in thin samples is investigated theoretically. (auth)

28135 APPARATUS FOR MEASURING THE ENERGY DEPENDENCE OF PROTON POLARIZATION IN ELASTIC SCATTERING. Adzhei, A. K.; Galakhmatova, B. S.; Kalacheva, Z. F.; (and others). Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 4, 393-7 (Jul-Aug 1971). (In Russian).

Equipment is described for the measurement of the angular and energy dependence of the polarization of protons during elastic scattering. An assembly of four multitarget chambers with attached polarimeters containing photographic film made it possible to conduct measurements at the angles 45°, 60°, 75°, 90°, 105°, 120°, and 135°. Operational characteristics of the polarimeters are discussed. (5 figures) (K.S.W.)

28136 FUNCTIONAL AND MORPHOLOGICAL EXPLORATION OF THE KIDNEYS. NEW TECHNIQUES. Floyrac, R.; Itti, R.; Besnard, J. C.; Planiol, T. (Centre Hospitalier Regional Bretonneau, Tours, France). Sem. Hop. Paris; 47: No. 53, 3049-56 (26 Dec 1971). (In French).

Some new techniques in radioisotope renography are presented. These techniques owe their existence to developments in certain equipment (particularly scintillation cameras) and automatic data processing. Complete renal investigation by radioisotopes includes: measurements of glomerular and plasmatic tubular clearances, and excretion; glomerular and tubular nephrograms; separate clearance measurements from each kidney; sequential views of the kidneys during various stages of the excretion of a labeled substance; and dynamic graphs of areas of interest selected from the renogram. All the information is obtained with a minimum of inconvenience for the patient. (France)

28137 RECENT ADVANCES IN PARTICLE ACCELERATORS. Blewett, John P. (Brookhaven National Lab., Upton, N. Y.). Advan. Electron. Electron Phys.; 29: 233-56(1970).

New ideas in accelerator technology including electron ring accelerators, heavy ion accelerators, and superconducting accelerators are reviewed. Also, progress in new and continued accelerator projects is outlined. Developments in proton synchrotrons, electron accelerators, storage rings and colliding beams, cyclotrons, and meson factories are summarized. (W.H.K.)

28138 ELECTRONIC INSTRUMENTATION OF THE TRAPPED RADIATION EXPERIMENT ON SIRIO SATELLITE. Cantarano, S.; Pallottino, G. V. (CNR, Rome). pp 759-75 of XI International Automation and Instrumentation Conference. Vol. 1. Milan; Federazione delle Associazioni Scientifiche e Technische (1970).

From eleventh international automation and instrumentation conference; Milan, Italy (23 Nov 1970). See CONF-701145-(Vol. 1).

A package of five scientific experiments called "Trapper Radiation Experiments" (T.R.E.) has been proposed and accepted on board the Italian geostationary satellite SIRIO. The experiments are concerned with measurements of protons from 50 eV to 20 MeV and electrons from 50 eV to 50 keV, as well as magnetic fields both static and variable, with the purpose of advancing the knowledge of the phenomena related to the trapped radiations. The electronic instrumentation of the experimental package that consists of detectors of particles and fields and of analog and digital data processors is described. Several new concepts and techniques are discussed that have been applied to T.R.E. in order to optimize the performance of the system within the boundary conditions of weight and power assigned to the experiments. The variable magnetic field detection system uses a two sensor correlation technique in order to reduce the effect of the noise of the measurement channel; the spectrum analyzer for measuring the power of the magnetic field in six frequency bands is realized by using a single filter whose time constants are switched with variable duty-cycle binary waveforms to provide six different frequency bands; the compression counters used for particle measurements have been optimized by giving a quantization error which is never greater than a preassigned fraction of the statistical error, due to counting events from a random source. (auth)

28139 ELECTRON MICROSCOPY STUDY OF THE TRACKS OF Cf FISSION PRODUCTS IN A THIN PLASTIC LAYER. Chambaudet, Alain; Roulet, Henri (Univ., Paris). Compt. Rend., Ser. B; 274: No. 2, 145-8(10 Jan 1972). (In French).

Various replica techniques were used in studying the nature of the tracks and the channel diameters as a function of the chemical development time. (France)

28140 USE OF IONIZATION CHAMBERS FOR THE CONTROL OF THE SPECIFIC ACTIVITY OF GASES AND LIQUIDS.

Kaftal, S.; Sangiust, V.; Terrani, S. (Politecnico, Milan). Minerva Fisiconucl.; 15: No. 1, 15-19(Jan-Mar 1971). (In Italian).

The use of ionization chambers in some measurements of health physics is considered. Three chambers in particular are illustrated: one with internal counting for the measurement of the specific activity of gases in the interval from 10^{-6} to about 1 $\mu Ci/cm^3$; a second (compensated chamber) for the control of the ^{85}Kr eventually evolved from a decay vessel for irradiated fuel elements; and a third for the measurement of the specific activity of liquids in the interval from about 2 $\mu Ci/cm^3$ to about 200 mCi/cm^3. The procedures used for the calibration and the possibilities of the three chambers are described. (tr-auth)

28141 COMPARISON BETWEEN THE FREE-AIR IONIZATION CHAMBER OF THE HEALTH PHYSICS LABORATORY OF THE C.N.E.N. OF BOLOGNA AND THE CHAMBERS OF OTHER EUROPEAN LABORATORIES. Busuoli, G.; Cavallini, A.; Lembo, L. (CNEN, Bologna). Minerva Fisiconucl.; 15: No. 1, 28-32 (Jan-Mar 1971).

The calibration of a free-air chamber for X-rays in the range 40 to 400 KV and the determination of its correction factors are described. The measurements were made between the laboratory standard and those of other European Laboratories. The comparison was performed by means of a cavity chamber used as a secondary standard. The deviations between the measured values are less than 1%. (auth)

28142 LIGHT PORTABLE INSTALLATION FOR HUMAN SPECTROMETRY USED FOR THE MONITORING OF INDIVIDUALS SUSPECTED OF INTERNAL CONTAMINATION. Maccario, J.; Perles, R.; Frossard, H.; Golhen, A. (Centre de Recherches du Service de Sante des Armees, Clamart, France). Radioprotection; 6: No. 4, 255-67(1971). (In French).

The development and practical application of a light, portable, and simplified human γ spectrometry unit is presented. This unit avoids the use of heavy sheet metal shielding and employs a collimated probe, a shielded chair, and a simplified electronic system. The results obtained with 137 healthy persons indicated that the effect of weight and height on the total counts could be neglected. The overall count distribution was Gaussian for individuals who were not abnormally contaminated. The abnormal body burden necessary to produce another Gaussian curve, clearly distinguishable from the first, for all the subjects of the primary population, was studied. If the risk of rejecting burdens of less than 1/100 of the maximum permissible body burden is accepted, contaminated persons can be separated from noncontaminated persons with a good measure of certainty. (France)

28143 PORTABLE INSTRUMENTS WITH BATTERIES THAT NEVER FAIL. Powell, T. J. (Univ. of Michigan, Ann Arbor). Health Phys ; 22: No. 4, 409-10(Apr 1972).

A simple modification is described to eliminate routine battery charging, and permit an instrument using nickel-cadmium batteries to be operated and recharged by connection to a 115 V a.c. power source. In the example shown, a Geiger counter Eberline Model E-130, was operated with fully discharged batteries and there was less than 1% ripple in the charging circuit. (UK)

28144 FIELD DETERMINATION OF DOSE FROM ^{133}Xe IN THE PLUME FROM A PRESSURIZED WATER REACTOR. Karches, G. J. (Northeastern Radiological Health Lab., Winchester, Mass.); Kolde, H. E.; Brinck, W. L.; Shearin, R. L.; Phillips, C. R. pp 515-23 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

A commercially available instrument designed for measuring low-energy gamma radiation was successfully utilized to monitor the plume from a pressurized water reactor (PWR). The detector consists of a $\frac{1}{16}$-in. thick by 5-in. diameter NaI (Tl) crystal optically coupled through a quartz light pipe to a 5-in. multiplier phototube. Pulses from the detector are sorted by use of a single-channel pulse height analyzer and read from a linear–log meter. The ratio of counting efficiency to background response (E^2/B) was optimized using a sample of the stored gas before release. Response of the instrument is compared with a tissue-equivalent ionization chamber to approximate the external dose to persons in or near the plume. The composition of the gamma-emitting radionuclides in the gas decay tanks is about 99% ^{133}Xe. During release of the gas from the decay tanks there were 3000 $\mu Ci/s$ of ^{133}Xe discharged. The instrument response at a distance of 0.4 mile was six times the background reading. At distances greater than one mile the plume was still easily detectable. Atmosphere stability conditions were neutral with very light wind at the time of the measurements. Gas samples were collected in the field at the boundary of the plant to check calculated atmospheric dispersion estimates. During approximately half the collection period readings above background were observed on the field instrument. The detector system described is applicable for "tracking" the plume from PWR's, and can also be used for estimating the dose to the population for both decay tank discharges and accidental releases. (3 figures, 3 tables) (auth)

28145 DOSE RATE METER FOR THE MEASUREMENT OF ENVIRONMENTAL RADIATION. Kolb, W.; Lauterbach, U. (Physikalisch-Technische Bundesanstalt, Brunswick). pp 565-72 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

As a continuation of the development of an already described dose-rate meter for radiation protection using a scintillator combination as detector, a portable instrument with measuring ranges between 72 fA/kg = 1 $\mu R/h$ and 7.2 pA/kg = 100 $\mu R/h$ full deflection was built. The instrument, reading in the energy range between 25 keV and 1.3 MeV, is energy independent within ±10%, and is used for rapid measurement of the dose rate of the environmental radiation, especially in rooms with low radiation background. The properties of the detector and the technical set-up of the dose-rate meter are described. (7 figures, 1 table) (auth)

28146 DOSIMETRIC CHARACTERISTICS OF SILICON DETECTORS WITH p-i-n JUNCTIONS. Larioshin, Yu. M.; Fedoseeva, O. P.; Titov, A. A.; Kosarev, V. S. (Moscow Roentgen-Radiological Inst.). Med. Radiol.; 16: No. 10, 70-6(Oct 1971). (In Russian).

The dosimetric characteristics of a series of Si detectors with p-i-n junctions were tested with γ and x radiation. Short-circuit current values, voltage without load, and internal resistances were measured as functions of the dose of ionizing radiation and other factors. The effect of the environmental temperature on the output parameters of the detectors was studied. Detectors were also exposed to radiation from ^{137}Cs with effective quantum energy of 650 keV, after which short-circuit current tests were made. (tr-auth)

28147 RECENT DEVELOPMENTS IN SEMICONDUCTOR NUCLEAR RADIATION DETECTORS. Eberhardt, J. E.; Ryan, R. D.; Tavendale, A. J. (Australian Atomic Energy Commission, Lucas Heights). Australas. Bull. Med. Phys. Biophys.; No. 52, 6-19(Mar 1972).

Recent advances in the field of semiconductor nuclear radiation detectors have made possible their wider use in biomedical applications, particularly in nuclear medicine. These detectors are basically simpler and more compact than the NaI(Tl) scintillation counter, while their higher energy resolution gives better discrimination against scattered radiation. However, their efficiency is lower. The temperature limitations of silicon and germanium have been overcome by the development of GaAs and CdTe. At present, applications are limited by the difficulty of growing large volume high purity crystals. However, small detectors operating at low voltages can be used in catheters and in miniature probes for the measurement of ^{32}P uptake in eye and cervical tumours. Large Ge detectors have been used to demonstrate the advantages of improved energy resolution with both the rectilinear scan and gamma camera radioisotope imaging systems. The high resolution at x-ray energies permits the use of fluorescence techniques in vivo and in the scanning electron microscope. (auth) (Australia)

28148 SPHERICAL HALOGEN GEIGER TUBE. Panther, Richard H.; Purser, Charles Ralph (to Her Majesty's Canadian Government). U. S. Patent 3,646,381. 29 Feb 1972. Priority date 19 Dec 1967, Canada.

A nondirectional halogen quenched Geiger tube having concentrically arranged spherical anode and cathode is described. The space between the electrodes is filled with a gaseous mixture of neon, argon, and bromine. (auth)

28149 QUENCHING AND ENERGY-TRANSFER IN HALOGEN-CONTAINING PLASTIC SCINTILLATORS. Volosyuk, G. P.; Petrova, I. B.; Prokofeva, L. S.; Gunder, O. A. Opt. Spectrosc. (USSR) (Engl. Transl.); 30: No. 3, 256-8(Mar 1971).

Translated from Opt. Spektrosk.; 30: No. 3, 466-71(Mar 1971).

The fluorescence and scintillation intensity of 1,3,5-Δ^2-triphenylpyrazoline (TPP) were studied in polystyrene as a function of the concentration of quenchers, namely halogen derivatives of benzene and styrene. The values of the quenching constants

have been determined for different types of excitation. It is shown that quenching by the chlorine derivatives of benzene arises from the excitation-energy transfer from polystyrene to the quencher via a dipole–dipole mechanism. The insertion of the quencher in the polymer chain somewhat increases the quenching efficiency. It is suggested that the more pronounced quenching by the bromine and iodine derivatives of benzene follows from an increase in the single–triplet transitions in the excited molecules of polystyrene due to the heavy-atom effect. (auth)

28150 ION IMPLANTED p-n JUNCTIONS IN NEAR INTRINSIC n-TYPE SILICON FOR NUCLEAR PARTICLE DETECTORS. Howes, J. H. (Atomic Energy Research Establishment, Harwell, Eng.). pp 414-19 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

The application of ion implantation to producing p–n junctions in high resistivity n-type silicon for the fabrication of detectors used in low-energy x-ray spectrometry is discussed. (auth)

28151 BORON IMPLANTED CONTACTS ON HIGH PURITY GERMANIUM. Ponpon, J. P.; Grob, J. J.; Stuck, R.; Burger, P.; Siffert, P. (Centre de Recherches Nucleaires Laboratoire de Physique, Strasbourg). pp 420-9 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Implantation of 15-keV boron ions was used to obtain rectifying contacts in high-purity germanium. The behavior of the implanted layers was investigated by electrical measurements and backscattering techniques. The results are quite different from those obtained for similar implantations in silicon. Appreciable electrical activity was observed in germanium even without annealing, and the damaged layers, for doses less than 10^{15} B^+ ions/cm^2, were found to anneal out at 170°C. Thus, satisfactory P^+ contacts on high-purity germanium nuclear counters can be made without high-temperature treatments. 1.26-keV fwhm for the 661-keV line of a ^{137}Cs γ source was obtained with such a detector. (auth)

28152 RESPONSE OF COVERED SILICON DETECTORS TO MONOENERGETIC GAMMA RAYS. Reier, Melvin (Jet Propulsion Lab., Pasadena, Calif.). Nucl. Sci. Eng.; 47: No. 4, 409-14(Apr 1972).

Measurements have been made of the efficiency in detecting gamma rays of a 0.3-mm-, 3-mm-, and 5-mm-thick silicon detector covered with different absorbers. Calibrated sources over the range from 279 keV to 2.75 MeV were used. The need for the absorbers to obtain meaningful results and their contribution to the response of the detectors at electron biases from 50 to 200 keV are discussed in detail. It is shown that the results are virtually independent of the atomic number of the absorber. In addition, the role of the absorber in increasing the efficiency with increasing photon energy for low bias settings is demonstrated for the 0.3-mm crystal. Qualitative explanations are given for the shapes of all curves of efficiency versus energy at each bias. (auth)

28153 RADIATION DETECTOR HAVING A SEMICONDUCTOR CRYSTAL. Meuleman, Johannes (to Philips Corp.). U. S. Patent 3,646,407. 29 Feb 1972. Filed 21 Sep 1970.

A radiation detector in which a semiconductor crystal having a substantially central cavity is used around which a radiation-sensitive junction is provided between two zones of opposite conductivity-types which may be separated by an intrinsic zone is described. The crystal is accommodated in a hermetically sealed envelope consisting of a boxlike holder and a cover, in which connection means for the crystal on the envelope consist of a rigid pin which is connected to the boxlike holder, said pin being guided between the aperture of the crystal and forcibly pressing therein against the wall of the cavity. (auth)

28154 RADIATION DETECTOR HAVING A CLAMPED CRYSTAL. Meuleman, Johannes (to Philips Corp.). U. S. Patent 3,646,410. 29 Feb 1972. Filed 17 Sep 1970.

A radiation detector which comprises a crystal having two coaxial zones of opposite conductivity types, is described. The zones may be separated by an intrinsic zone, between which first-mentioned zones a radiation-sensitive junction is formed, the crystal being secured in a hermetically sealed envelope consisting of a boxlike holder and a cover. The connection consists of a clamping support which encloses the crystal and which is secured to the boxlike holder. (auth)

28155 METHOD FOR QUALITY CONTROL OF LOW-ENERGY X-RAY GAMMA DETECTORS. Berlovskii, A. Ya.; Sagaida, N. S. Meas. Tech. (USSR) (Engl. Transl.); 14: No. 9, 1401-3(Sep 1971).

Translated from Izmer. Tekh.; 14: No. 9, 72-3(Sep 1971).

A quality control method for low-energy x-ray and γ scintillation detectors based on light yield measurements with a standard photomultiplier is described. (W.H.K.)

28156 EFFECTIVE THICKNESS OF THE DEAD LAYER OF SILICON DRIFT DETECTORS. Podenko, N. P.; Stepanov, E. K. Meas. Tech. (USSR) (Engl. Transl.); 14: No. 9, 1457-8(Sep 1971).

Translated from Izmer. Tekh.; 14: No. 9, 105(Sep 1971).

The α energy loss as a function of the operating voltage in the dead layers of surface-barrier silicon detectors was measured. The results are presented and briefly discussed. (W.H.K.)

28157 SOLID STATE TRACK DETECTORS. Blanc, Daniel (Univ., Toulouse). pp 96-125 of Radiation Dosimetry. Vol. 2. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

The subject of dielectric track detectors is reviewed. After a brief historical background, latent track properties are discussed. The properties of the developed track are next considered—development technique, conditions under which a track is developable, and etch rate along the trajectory. Counting of developed tracks and particle spectrometry are discussed. Track formation mechanisms are described. Applications of these detectors in the measurement of time intervals, fundamental physics studies concerning nuclear reactions, cosmic rays, microanalysis, geochronology, astrophysics, space radiation protection, neutron detection and dosimetry, and biology are briefly reviewed. (9 figures, 7 tables) (R.W.R.)

28158 CURRENT PROBLEMS AND EXPERIMENTAL RESULTS IN MICRODOSIMETRY. Srdoc, Dusan (Inst. Rudjer Boskovic, Zagreb. Columbia Univ., New York). pp 316-25 of Radiation Dosimetry. Vol. 2. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

The extension of gamma energy loss distribution measurements in tissue to very small spherical volumes is discussed. Factors that determine the performance of the counter are considered. Construction of a gridless tissue-equivalent spherical proportional counter and miniature x-ray tube for calibration purposes are described. Energy deposition probability curves for ^{60}Co gamma rays are given for spheres of tissue 0.5, 1, and 2 μm in diameter. The performance of these counters deteriorates at low pressures, partly because of the wall effect. A modification of the Rossi counter is described which results in lowering the minimum size represented by the counter and in a substantial reduction of the wall effect. (7 figures) (R.W.R.)

28159 NOTE ON DETECTABILITY ENHANCEMENT OF WEAK NEUTRON BURST SIGNALS THROUGH MULTIPLICATION. Porges, K. G. (Argonne National Lab., Ill.). Nucl. Technol.; 14: No. 2, 194-6(May 1972).

Certain reactor safety instrument channels require the assured detection of weak neutron bursts in the presence of strong gamma background. Inasmuch as the importance of some such channel justifies a fairly elaborate detection system, neutron multiplication suggests itself as a means of enhancing the signal strength relative to the background. While such a system may be technically feasible, it is subject to severe limitations inherent in the statistical nature of multiplication, which are studied. In particular, it is shown that, given a reasonably high intrinsic neutron detection efficiency, the statistical quality of detection is optimized for relatively weak multiplication factors and worsens again as multiplication increases. The overall design of a multiplying detection system is in fact a matter of considerable complexity since multiplication affects source geometry and energy distribution as well as statistics. A potential application is the detection of fuel failures in a LMFBR Plant by monitoring the coolant flow system for delayed neutrons downstream from the core. (auth)

28160 SPARK CHAMBERS AND THEIR APPLICATIONS TO NUCLEAR MEDICINE. Lansiart, Alain (CEN de Saclay, Gif-sur-Yvette, France). Ann. Phys. Biol. Med.; 5: No. 4, 187-204 (1971). (In French).

Different types of spark chambers are classified, particular attention being given to detectors of medium and low energy x, γ, and β radiations used in nuclear medicine. Chambers functioning

by wall effects are distinguished from those in which the incident particle produces the spark by interaction with the gas only. (France)

28161 CORRECTION OF SINGLE PHOTON OR PARTICLE TIMING MEASUREMENTS FOR MULTIPARTICLE EVENTS. Donohue, David E.; Stern, Richard C. (Columbia Univ., New York). Rev. Sci. Instrum.; 43: No. 5, 791-6(May 1972).

In particle time of flight or photon timing measurements, usually only the first event can be timed. An algorithm is derived which uses the measured distribution of first arrivals and a measured or assumed distribution of events per sweep to generate the desired distribution of all arrivals. The theory is shown to work at all values of the average count rate per sweep by comparison with computer simulated experiments. It is found that the optimum recovery of information at long times occurs at an average count rate per sweep of 1. (auth)

Radiation Dosimeters

Refer also to abstracts 28837 and 29966.

28162 (BNWL-1641) PROBABILITY MODEL FOR THERMOLUMINESCENT DOSIMETRY. Beetle, Thomas M. (Battelle Pacific Northwest Labs., Richland, Wash.). Jan 1972. Contract AT(45-1)-1830. 46p. Dep. NTIS.

The trapped electron description of the thermoluminescence dosimetry mechanism is used to derive a probability model for the dosimetry measurements. Means and variances of measurement distributions can be approximated by linear and quadratic functions of exposure levels. Data from the Hanford Basic Thermoluninescence Dosimetry Process are used to develop precision specifications and audit procedures for that process. (auth)

28163 (HASL-251) SOME IMPLICATIONS OF A LABORATORY STUDY OF LiF DOSIMETERS FOR ENVIRONMENTAL RADIATION MEASUREMENTS. Shambon, Arthur (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Mar 1972. 28p. Dep. NTIS.

A lower limit for dose measurements with commercial ^{7}LiF solid dosimeters used in conjunction with special thermoluminescent readers is established. Perturbing factors, such as oxygen and water vapor in the nitrogen gas flow of the readers, smoothness of detector surface, and change of dosimeter color are discussed. Fading under an assumed extreme environmental monitoring condition of 125°F for 120 hours was examined. Measurements from a large number of dosimeters were made at several radiation exposures to determine the standard deviations from the mean for single dosimeters and the means for samples sizes of 5 and 10 dosimeters. The dose-response linearity from less than one-half to 60 mR was investigated and the feasibility of measuring a 10% change at the 10 mR level evaluated. (auth)

28164 (HASL-252) INVESTIGATION OF A CaF_2:Mn THERMOLUMINESCENT DOSIMETRY SYSTEM FOR ENVIRONMENTAL MONITORING. Burke, Gail de P. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Apr 1972. 24p. Dep. NTIS.

Commercially-produced, glass encapsulated CaF_2:Mn thermoluminescent dosimeters were investigated for low level environmental radiation monitoring. The study included extensive laboratory testing of the performance of the dosimeters at exposure levels of 1 to 10 mR, the range expected in environmental monitoring over periods of 1 to 4 weeks. Sixty-two dosimeters were tested for accuracy, precision, sensitivity, response to dose, directional dependence, fading and self-irradiation. A standard procedure was devised based on the parameters studied. The capability of the system and validity of the analyses were verified by a 1 mR trial exposure in a known laboratory radiation field. The test revealed that if the appropriate corrections are not made, particularly that for self-irradiation, the exposure may be overestimated by as much as a factor of two. If used in accordance with the procedure developed, the CaF_2:Mn dosimeters provide an accurate and effective method for environmental radiation monitoring. (auth)

28165 (HASL-TM-71-17) EVALUATION OF MOD AND ORNL RADON DAUGHTER DOSIMETERS. White, Otto Jr. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 8 Oct 1971. 41p. Dep. NTIS.

Dielectric track and thermoluminescent (TL) air-flow dosimeters were evaluated for monitoring exposures of uranium miners to radon daughter products. The performance of the TL dosimeter was very good in laboratory tests but only fair in mine tests; the overall performance of the other dosimeter was unsatisfactory in both types of tests. (13 figures, 13 tables) (R.W.R.)

28166 (HASL-TM-71-22) PRELIMINARY ENVIRONMENTAL RADIATION TESTS WITH TL DOSIMETRY. McLaughlin, J. E.; Weinstein, M. S.; Shambon, A.; Burke, G. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Dec 1971. 18p. Dep. NTIS.

LiF and CaF_2:Mn TL dosimeters were worn for periods up to about two weeks in an attempt to determine if meaningful measurements of personnel gamma-ray exposures from background radiation can be made. The tests were done during usual laboratory work, urban/suburban living and trips by commercial air and surface travel. The results were in qualitative agreement with gamma-ray exposures estimated from other HASL in situ natural terrestrial and cosmic radiation measurements. However, great care is needed in preparing and reading out the dosimeters and properly accounting for self-irradiation, fading and dosimeter-reader response. It is concluded that any large-scale, low-level population radiation exposure survey would be feasible though difficult, because careful dosimeter evaluations would be necessary before measurements could be converted into dose data. (auth)

28167 (JAERI-M-4579) EFFECT OF TRITIUM ON THE FILM DOSIMETERS. Kuroda, Hayao; Sasanuma, Yoshio; Ito, Masashi (Japan Atomic Energy Research Inst., Tokyo). Sep 1971. 15p. (In Japanese). NTIS (U. S. Sales Only).

The personnel film dosimeter used in a tritiated atmosphere is blackened by soft β-rays from tritium permeating into the film emulsion. In this experiment, the distribution of fogging and the variation of density dose with exposure time were observed for the film dosimeter. The glass and the glass-encapsulated thermoluminescent dosimeters were also tested to find their dose sensitivities in a tritiated atmosphere. (auth) (Japan)

28168 GAMMA-RAY DOSIMETRY BY MEANS OF PROPORTIONAL COUNTER. I. FUNDAMENTAL CHARACTERISTICS OF PLASTIC WALL COUNTER. Nakashima, Yoshiyuki; Kawano, Minoru (Nagoya Univ., Japan). J. Nucl. Sci. Technol. (Tokyo); 9: No. 1, 47-52(Jan 1972).

The relation between exposure rate and energy loss of secondary electrons in the sensitive volume of a plastic wall counter is derived. The possibilities presented by a proportional counter for use in dosimetry were examined for the case of a combination of polyethylene wall and methane gas. Absolute measurement was found possible by calibration of the observed pulse-height distribution. It was also shown that low exposure rates could be effectively measured with counters provided with a small sensitive volume. The characteristics of the counter when used as a dosimeter proved very close to those of an ionization chamber. (auth)

28169 THERMOLUMINESCENT DOSIMETER ENCODING AND READOUT METHOD. Jones, Donald E.; Petrock, Kermit F. (to United States Atomic Energy Commission). U. S. Patent 3,638,017. 25 Jan 1972. Filed 23 Dec 1969.

A system and method for encoding personnel or other type of identification data from a computer center on a holder for dosimetric material and automatically removing from the holder the material and reading out radiation dosage thereon while decoding the identification data on the holder and transmitting the readout and decoded data to the computer center are described. The encoding is accomplished in such a manner as to substantially eliminate accidental or intentional errors while the dosimetric material is removed by vacuum means and readout in a hot oxygen-free gas, such as nitrogen. (auth)

28170 NEW FREE RADICAL RADIOLOGICAL DOSIMETER. Bermann, Francis (to Commissariat a l'Energie Atomique). French Patent 2,067,163. 20 Aug 1971. Filed 18 Nov 1969. (In French).

A free radical radiological dosimeter was developed. It contains a mixture of a free radical generating substance and one or several other substances, which enhance the yield of free radicals for a given radiation dose. (France)

28171 RADIOPROTECTION OF THE PATIENT DURING RADIODIAGNOSIS: CHOOSING THE DOSIMETERS. Boulenger, R. J. Belge Radiol.; 54: No. 6, 727-33(Nov-Dec 1971). (In French).

The choice of dosimeter to be used during radiodiagnosis depends on the energy of the radiation and the dose anticipated. Because of the large energy range involved (5 to 150 keV), it is necessary to use a dosimeter made of a material that is as tissue-equivalent as possible, with a sensitivity as energy-independent as possible in the range under consideration. The doses to be measured are liable to vary from mrads to hrads. The principles of operation of ionization chambers, photographic films, glass dosimeters, and thermoluminescent dosimeters are reviewed. It is concluded that the only dosimeters to meet all the necessary require-

ments are LiF thermoluminescent dosimeters. (2 figures, 1 table) (R.W.R.)

28172 CURRENT LOOK AT THERMOLUMINESCENT DOSIMETRY (TLD) IN PERSONNEL MONITORING. Attix, F. H. (Naval Research Lab., Washington, D. C.). Health Phys.; 22: No. 3, 287-91(Mar 1972).

Results of a questionnaire are presented, answered by a mixed range of institutions, 58 from the U. S. A. and 47 from Worldwide establishments. It was found that although TLD is widely used, only 13% of the institutions used this method for routine record-keeping personnel monitoring, the film-badge retaining its position mainly on economic grounds. However, TLD was the method of choice for hand dosimetry. Readout automation is developing, especially at the Lawrence Radiation Laboratories. The use of TLD for personnel monitoring is limited mainly to $\beta\gamma$ applications because of the low direct response of known TL phosphors to fast neutrons. Almost all the laboratories accept the necessity of retaining records over many years. (UK)

28173 FILM BADGE PERFORMANCE CRITERIA. New York; American National Standards Institute ([(1970)]. 16p.

A set of minimum performance criteria for film badges is given for exposure under specified conditions to beta, neutron, photon, and mixed radiation fields. Because performance criteria are intimately connected with the methods of testing, a testing procedure is described. Since it is the intention in this standard to consider the performance of film badge dosimetry under the most reproducible conditions, uncertainties introduced by scattering, unspecified radiation sources, and nonuniform irradiations are eliminated from the prescribed procedures insofar as possible. The problems related to the use of film badges for personal dosimetry, therefore, are not considered in this standard. Some "principles of good practice" in film badge dosimetry are included. (3 tables) (R.W.R.)

28174 PASSIVE CALORIMETER FOR PULSED ELECTRON BEAM ENERGY MEASUREMENT. Stephens, H. P.; Donaldson, A. B.; Heckman, R. C. (Sandia Labs., Albuquerque, N. Mex.). Rev. Sci. Instrum.; 43: No. 4, 614-19(Apr 1972).

A passive calorimeter for diagnostics of high energy pulsed electron beams is described. It consists of a thin rectangular sheet which is irradiated by the electron beam in a central region. The generated heat diffuses outwardly to the ends so that each position experiences a temperature maximum. Thin strips of materials which melt at various temperatures are coated on the surface to provide a record of the temperature maxima of the calorimeters. The corresponding heat diffusion problem is analyzed and used with the experimental results to calculate the initial temperature of the irradiated region, and thus the dose. The calorimeter absorbs only a small fraction of the beam energy and is therefore useful for making dose measurements simultaneously with experiments. (auth)

28175 PHOSPHOR FOR THERMOLUMINESCENT RADIATION DOSIMETER. Nada, Naohiro; Yamashita, Tadaoki (to Matsushita Electric Industrial Co., Ltd.). U. S. Patent 3,637,518. 25 Jan 1972. Priority date 9 Feb 1968, Japan.

A phosphor for a thermoluminescent radiation dosimeter, which is composed primarily of beryllium oxide doped with at least one activator selected from the group consisting of lithium, sodium, potassium, silicon, germanium, tin, zinc, cadmium, aluminum, thallium, cadmium and ytterbium is described. The phosphor is especially adapted for measuring the dose absorbed by a tissue since its effective atomic number is approximately the same as that of the tissue, and it has an excellent sensitivity and retention of radiation energy absorbed. (auth)

28176 NEUTRON ROUTINE DOSIMETRY USING SOLID-STATE TRACK DETECTORS. Doerschel, B. (Technische Univ., Dresden). Kernenergie; 14: No. 11, 360-3(Nov 1971). (In German).

Fissile layers of high sensitivity are necessary for the use of solid-state track detectors in routine monitoring. The conditions for manufacturing sprayed ^{235}U layers and pressed ^{232}Th tablets are described. Track density is determined by visual counting of etch pits on a television screen. The neutron fluences and dose equivalents for thermal, intermediate, and fast neutrons can be calculated using mathematical relations and well-known conversion factors. The calculations have been verified by experiments in various neutron fields. The required measuring range of 0.1 to 50 rem is realized for thermal, intermediate, and fast neutrons without the maximum permissible error limits of ±30 percent being exceeded. Testing of the routine dosemeter was performed with the (d,d) generator (TU Dresden, AuBenstelle Pirna–Copitz) and the WWR-S reactor (ZfK Rossendorf). (auth)

28177 NEUTRON EMERGENCY DOSIMETRY USING SOLID-STATE TRACK DETECTORS. Doerschel, B. (Technische Univ., Dresden). Kernenergie; 14: No. 10, 333-7(Oct 1971). (In German).

Utilization of solid-state track detectors in emergency dosimetry is possible if fissile material layers of appropriate thickness are available. Very thin films of enriched uranium may be manufactured by spraying uranyl nitrate on to aluminum backing under the action of a strong electric field. For manufacturing comparatively thick layers of natural uranium the electroplating technique is utilized. In a dosemeter badge, mica detectors, fissile layers, and cadmium filters are arranged in such a manner that the fluences of thermal, intermediate, and fast neutrons may separately be determined. Track density is determined by measuring the α-permeability of the etched mica detectors. The neutron fluences from which the neutron doses can be derived by using well-known conversion factors can be calculated from the track densities by means of mathematical relations. Testing of dosemeters was made in various neutron fields, whereby the derived relations between neutron fluence and track density have been verified. A discussion of measuring ranges and accuracy shows that the doses to be measured are in the required range of 1 to 1000 rad and that the maximum permissible deviations of −20 and +30 percent are not exceeded. (auth)

28178 SOME SPECIAL PROBLEMS IN DEVELOPING HIGH-DOSE COUNTERS. Bartho, H. (VEB RFT Messelektronik, Dresden). Kernenergie; 14: No. 10, 337-40(Oct 1971). (In German).

Starting from the measurements of detectors for high dose rate measurements, the relations between dose sensitivity, counter dead time, and "normalized" slope of pulse rate/dose rate characteristic are discussed. From this, conditions for electrode geometry and filling pressure are derived which have influence on aftercounts and, consequently, on plateau characteristics (plateau length and plateau slope). Material problems and special technological methods are given with respect to temperature and lifetime behavior. The review is completed by technical data of the high dose counters VA-Z-261, VA-Z-261A, VA-Z-262.2. (auth)

28179 TRENDS IN DEVELOPMENT OF INDIVIDUAL DOSIMETRY OF OCCUPATIONALLY EXPOSED MEN. Kraus, W.; Will, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Kernenergie; 14: No. 9, 277-83(Sep 1971). (In German).

A review of the recent state of individual dosimetry of occupationally exposed men is given. The properties of recent solid-state detectors (thermoluminescent, photoluminescent, exoelectron, and track detectors) and their applicability to routine and accidental dosimetry or in plant and central monitoring are discussed. In particular, advantages and drawbacks of the recent detectors are presented as compared with film dosimeters and the state attained in substituting or complementing the film dosimeter is shown. Trends of future development are estimated. (auth)

28180 ROUTINE USE OF THERMOLUMINESCENCE DOSIMETRY FOR RADIATION THERAPY. Gooden, David S.; Brickner, T. J. (St. Francis Hospital, Tulsa, Okla.). Radiology; 102: No. 3, 685-9(Mar 1972).

A complete thermoluminescence dosimetry system is described. New techniques for dosimeter pairing, grouping, calibration, and annealing are suggested. This system is well suited for routine dosimetry, and shows particular advantage in unusual size and shape of fields such as tangential breast fields and rectal and vaginal dosimetry. The system can be used for external beam dosimetry, intracavitary dosimetry, and calibration of treatment cones. It has shown a reproducibility of ±2% and an estimated clinical accuracy of ±4%. (auth)

28181 MEASUREMENT OF EXPOSURE AND THE POSSIBILITIES OF ENERGY DETERMINATION WITH FILM DOSIMETER, IN CASE OF MIXED ENERGY PHOTON RAYS. Bojtor, Istvan. Izotoptechnika; 14: No. 9, 412-26(Sep 1971). (In Hungarian).

A study of spectra measurements of photons using a cassette film dosimeter and various filters is described. (W.H.K.)

28182 NEUTRON DOSIMETRY USING MULTI-SPHERE SPECTROMETER. Gomaa, M. A.; Abdel-Razek, M. (Atomic Energy Establishment, Cairo). Health Phys.; 22: No. 4, 355-7(Apr 1972).

The neutron spectrum was measured for a shielded Pu–Be source and near the experimental shield of one of the horizontal channels of the UA–RR–1 reactor using a multisphere spectrometer. Total neutron dose-rate (D) was computed by the following relation. $D = 0.663\ C_4 + 0.211\ C_3 - 0.348\ C_2 - 0.016\ C_1$, where C_1

and C_2 are the count rates due to a slow neutron detector, bare and cadmium covered, respectively. C_3 and C_4 are the count rates when the same detector is covered by 8 and 12 in. moderating spheres, respectively. The total neutron dose-rate evaluated by the single sphere neutron rem-meter was in agreement with the neutron dose calculated by the multi-sphere method. (auth) (UK)

28183 ENERGY RESPONSE OF LITHIUM BORATE THERMOLUMINESCENT DOSIMETERS. Thompson, J. J.; Ziemer, P. L. (Purdue Univ., Lafayette, Ind.). Health Phys.; 22: No. 4, 399-401(Apr 1972).

A study was made of the energy response of $Li_2B_4O_7$: Mn, including a spectrochemical analysis of impurities in the commercial product obtained from Harshaw Chem. Co. The theoretical energy response curve was calculated from the ratios of the mass energy absorption coefficients for the lithium borate phosphor and of air at various energies, divided by the same ratio at 1.25 MeV. The curve indicated that $Li_2B_4O_7$: Mn will under-respond by 1 to 9% relative to its response to ^{60}Co in the energy region 10 to 100 keV. Ten groups of 5 dosimeters each were exposed to 10 R of x and γ radiation. The x ray energies were from 13 to 183 keV and the ^{60}Co and ^{137}Cs sources provided 1250 and 660 keV γ rays. Dosimeters were read after 48 h. The energy response data suggested that the thermoluminescent response of $Li_2B_4O_7$: Mn was proportional to the absorbed dose and the data were within experimental error of the theoretical curve. (UK)

28184 ALUMINUM OXIDE THERMOLUMINESCENCE PROPERTIES FOR DETECTING RADIATION. Buckman, W. G. (Western Kentucky Univ., Bowling Green). Health Phys.; 22: No. 4, 402(Apr 1972).

Commercial, nominally pure Al_2O_3 crystals, studied at the Western Kentucky University, contained a broad peak in the flow curve around 165°C with an emission band centred near 4100 Å. It is suggested, that if it were possible to identify the impurity responsible, Al_2O_3 crystals would be useful as an ultraviolet detector, and also for x- and γ-rays, particularly below 500 keV when Al_2O_3 thermoluminescence is highly energy-dependent. (UK)

28185 HIGH DOSE-LEVEL RESPONSE OF CERAMIC BERYLLIUM OXIDE. Crase, K. W.; Gammage, R. B.; Becker, K. (Oak Ridge National Lab., Tenn.). Health Phys.; 22: No. 4, 402-5(Apr 1972).

A procedure is described for studying the response of BeO radiation detectors. Uniform heating of the surface of the sample and minimizing of heat losses reduced the thermal gradient across the emitting surface, resulting in a better peak resolution of the thermally stimulated electron emission (TSEE). The response was studied with ^{60}Co and ^{137}Cs γ radiation, α particles from a thin ^{239}Pu source, and 10 keV electrons. The effects on the main TSEE peak at ~325°C are illustrated. Saturation doses were ~2×10^4 and 3×10^5 rads for γ and β radiations respectively. After α exposure, no saturation occurred up to 10^{15} rad. TSEE peaks at ~450°C and 535°C showed saturation effects at ~3×10^4 and ~3×10^3 rads with γ radiation. The peak at ~325°C was shifted to lower temperatures with dose increase. The maximum observed shift was 50°C. Gamma and β radiation up to 10^7 rad had no observable permanent effect on the detectors. Alpha radiation caused semipermanent lattice damage after exposures as low as 3×10^3 rads. (UK)

28186 POSSIBILITIES FOR MEASURING THE ACCUMULATIVE RADIATION DOSAGE IN THE VICINITY OF NUCLEAR PLANTS. Winter, M. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). pp 525-35 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

The use of a large number of cumulative solid-state dosimeters for environmental monitoring of nuclear plants produces, with little effort of time and money, an accurate picture of the local distribution of the radiation dosage in the vicinity. The application of such dosimeters is, therefore, especially interesting for contractors of nuclear plants. Aside from routine monitoring, an existing network of measuring sites with solid-state dosimeters offers an important aid for a rapid first-dose estimation for the population after an accidental release of radioactive products. The properties of different types of dosimeters (phosphate-glass dosimeters, thermoluminescent dosimeters (LiF and CaF_2 dosimeters), and exoelectron dosimeters) are compared and discussed with regard to their application in environmental monitoring. In particular, practical problems in mounting such dosimeters in the field are examined, and the evaluation of the irradiated dosimeters with respect to a rapid collecting of results in connection with a rapid method is discussed. Phosphate-glass dosimeters and thermoluminescent dosimeters have been operating for many years in the vicinity of the Karlsruhe Nuclear Research Center. The existing network includes more than 200 measuring sites. The results of the measurements are reported. (3 figures, 5 tables) (auth)

28187 QUICK AND CONVENIENT MEASUREMENT METHOD FOR SURFACE AND LIQUID CONTAMINATION USING THE TLD SYSTEM. Naba, K.; Hefner, A.; Tritremmel, C. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Vienna). pp 549-63 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

At the present time and in the near future, underground nuclear explosions will often be used for peaceful uses, and sometimes accidental radioactive contamination may occur in the area surrounding an atomic power plant. These contaminations will be spread over a wide area and occur under different environmental conditions. In considering the measurement of contamination, TLD is believed to be a quick method in this connection. The TL material LiF: Mg was developed from a new starting material, named NTL-35, 50 series. For measuring contamination quickly in the field the necessary properties of TL material were studied. As a result, the following properties of NTL-50 make it suitable for field measurements: usability without annealing before irradiation; no change in response during irradiation below 40°C; no fading after exposure below 40°C; sensitivity linear from 1 mR to 10^4 R; sensitivity for beta radiation and small energy dependence for low-energy photons; and low cost. Some experimental measurements using TLD simulating surface and water contamination were made with several kinds of beta or gamma emitters, for example ^{147}Pm, $^{90}Sr-^{90}Y$, ^{137}Cs, ^{60}Co, etc., and the levels of surface contamination were from 10^{-4} $\mu Ci/cm^2$ to 10^{-2} $\mu Ci/cm^2$. Water contamination with the same nuclides at several concentrations was also investigated. As a result, NTL-50 from TL material seems to be a suitable method for quickly measuring surface contamination in the field, but some problems which arise from the effect of sunlight and the beta sensitivity upon TL material have not yet been solved. This quick method of using TLD will also have likely applications for monitoring in a radiation control area. (6 figures, 7 tables) (auth)

28188 NUCLEAR ENTERPRISES 0.6 CM^3 THIMBLE CHAMBER FOR FARMER DOSEMETER AND IONEX INSTRUMENTS, EQUILIBRIUM TIME. Brit. J. Radiol.; 45: No. 531, 232(Mar 1972).

Attention is drawn to modifications made in the design of the Nuclear Enterprise thimble chamber to provide a more specific channel from internal volume to external atmosphere. Since an N.P.L. calibration in March 1971, all chambers have had the modification and their equilibrium time measured. It is suggested that should customers believe the equilibrium time exceeds 10 min, the chambers should be returned for modification. (UK)

28189 PRESSURE TIME-CONSTANTS FOR 0.6 CM^3 FARMER IONIZATION CHAMBERS. Robinson, A. (Western Park Hospital, Sheffield, Eng.). Brit. J. Radiol.; 45: No. 531, 231-2(Mar 1972).

The pressure time-constants for nine 0.6 cm^3 Farmer ionization chambers in the Sheffield area were checked, including one with a nylon wall material that was suspected of being sealed off to atmospheric temperature and pressure changes. The observations were carried out using a ^{90}Sr reference source, (Nuclear Enterprises Ltd., type 2503), giving an exposure rate of 10 R/min and a corresponding ionization current of about 33 pA. Seven had time constants (the interval for 63% of the change in ionization current) of up to 6 s, one was about 80 s, and the suspected chamber had a time constant of at least several days. It is suggested that checks should be repeated at least annually, or after dismantling, and that for practical purposes constant corrected readings are obtained over a 10% pressure range and within a few minutes of a change in pressure. (UK)

28190 INTERCALIBRATION OF FILM DOSIMETERS OF THE ITALIAN SERVICE OF PERSONNEL DOSIMETRY. PART II. Busuoli, G.; Cavallini, A. (CNEN, Bologna). Minerva Fisiconucl.; 15: No. 1, 33-7(Jan-Mar 1971). (In Italian).

The Italian Service of Personnel Dosimetry has a program of standardization of personnel dosimeters. The program consists in the comparison of dosimeters for various types of radiation. The results obtained in the course of the last three years are summarized. (J.S.R.)

28191 CHEMICAL DOSIMETRY OF PHOTON-, NEUTRON, AND β-IRRADIATIONS WITH FERROUS–FERRIC SYSTEMS (FRICKE DOSIMETRY). Meissner, J.; Wendorff, D. Atomenergie; 19: No. 2, 127-32(Apr 1972).

Investigations concerning Fricke-dosimetry for the range of soft X-radiations have been extended to X-rays up to 300 kV tube voltage and ^{137}Cs-γ-rays. In addition to these external irradiations of the Fricke solution, internal ones have been performed by radionuclides of different β-energies. The absorbed doses of the photons are calculated with regard to experimentally measured attenuation coefficients and exposures (equilibrium ion-doses). For β-irradiations, calculations of absorbed doses are based on mean energies and radioactive concentrations. Within standard deviations limits the G-values determined are in accordance with ICRU-graphs (Handbook 85), plotting G-values against LET. By Frick dosimetry of recoil protons of a 14,2 MeV neutron source, neutron flux density is calculated using reference data for the Q-value and LET and results are compared to those of activation detector measurements. (auth)

28192 POTENTIOMETRIC ESTIMATION OF MEGARAD DOSE WITH THE CERIC–CEROUS SYSTEM. Matthews, R. W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Int. J. Appl. Radiat. Isotop.; 23: No. 4, 179-85(Apr 1972).

Use is made of the well-defined ceric–cerous redox couple to measure ceric concentrations in ceric–cerous dosimeters by potentiometry instead of by the usual spectrophotometric procedure. An equation is given relating dose to the difference in electrochemical potential between irradiated and unirradiated solutions. Results are presented for two concentration ranges covering doses from 1 to 2.5 Mrad and from 2 to 4.5 Mrad. Doses calculated from the measured potentials seldom differed by more than 1 to 2% from those obtained by ferrous sulphate dosimetry. The method is suitable for routine dosimetry since no dilution is required and measurements can be made as rapidly as a pH determination. The equipment required is simple and measurements can be made on as little as 0.2 ml of solution. (auth) (UK)

28193 THERMOLUMINESCENT RESPONSE OF LITHIUM FLUORIDE TO HIGH ENERGY PHOTONS. Turner, Alexander Pendleton. Norman, Okla.; Univ. of Oklahoma (1971). 115p. University Microfilms Order No. 72-9050.

Thesis.

Most recent investigators have found a ten percent decrease in thermoluminescent response per rad for lithium fluoride from cobalt-60 gamma rays to electrons and X-rays up to 35 MeV. This decrease was predicted from cavity theory calculations. Only a few of the investigators, however, observed a decrease in response with increasing electron or X-ray energy, and this decrease was faster than predicted from cavity theory calculations. This study confirmed the ten percent decrease in response using lithium fluoride TLD-700 high sensitivity rods in the 35 to 65 MeV X-ray energy range. This decrease was also predicted from cavity theory calculations. In this study, however, no difference was observed between the measured thermoluminescent responses at 35, 50, or 65 MeV. Cavity theory predicted about a one percent decrease in response over this energy range, but considering the approximations used in this calculation, the predicted response can also be assumed to be flat. In radiation dosimetry, thermoluminescent dosimeters are usually calibrated with cobalt-60 in order to make dose determinations at different energies. This study has extended the usefulness of this procedure to 65 MeV. (Diss. Abstr. Int., B)

28194 RADIATION DOSIMETRY. VOL. 2. Proceedings of the International Summer School on Radiation Protection, Cavtat, Yugoslavia, September 21–30, 1970. Miric, I. (ed.). Belgrade; Boris Kidric Institute of Nuclear Sciences (1971). 362p. (CONF-700939–(Vol.2)).

A separate abstract was prepared for each of the 17 papers in this volume. (R.W.R.)

For abstracts of individual papers see: 28157, 28158, 28195–28207, 28233, and 29967.

28195 METHODS AND TECHNIQUES FOR CALIBRATION OF RADIATION PROTECTION MONITORING INSTRUMENTS. Dorofeev, G. A. (International Atomic Energy Agency, Vienna); Larson, H. V.; Thompson, I. M. G. pp 3-59 of Radiation Dosimetry. Vol. 2. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

A review of some techniques and methods applied to calibration of secondary-standard radiation protection monitoring instruments and a summary of the existing experience in different countries is given. The lecture deals mainly with calibration of instruments designed for measuring external radiation, i.e., gamma and neutron fields, alpha and beta surface contamination. Calibration of neutron instruments with sealed neutron sources and accelerators and of gamma dosimeters with sealed gamma sources and x-ray machines is given in some detail. The similarity method for subrange linearity checks is shown to be of great importance for small calibration units. Some working procedures of calibration are described. (19 figures, 6 tables, 79 references) (auth)

28196 IONIZATION CHAMBERS FILLED WITH DIELECTRIC LIQUID: THEIR USE IN RADIATION PROTECTION. Blanc, Daniel (Univ., Toulouse). pp 75-95 of Radiation Dosimetry. Vol. 2. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

The importance of the detectors developed at Toulouse for work in radioprotection is underlined. Previous attempts are reviewed. Details of fillers resembling biological tissue and of the rate-meters using such fillers are given. An interesting application of these detectors is in the measurement of the quality factor of a radiation, the constitution or the energy of which is imperfectly known. Results of measurements carried out at the GeV SACLAY proton synchrotron are given. Finally, it is shown how these chambers can measure with high precision the depth doses from fast monoenergetic electron beams (up to 20 MeV). This fact is of great importance in radiotherapy. (15 figures, 1 table) (auth)

28197 PERSONNEL MONITORING WITH RADIOPHOTO-LUMINESCENT DOSIMETERS. Piesch, E. (Karlsruhe Nuclear Research Center, Ger.). pp 159-87 of Radiation Dosimetry. Vol. 2. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

A brief introduction is given into the dosimetric properties of silver-activated phosphate glass dosimeter systems. With this and on the results of calibration test exposures and of five years' routine dosimetry as a basis, personnel monitoring with glass dosimeters is described with particular attention to the technical requirements for the dose evaluation (identification of glass, washing of glass, predose, reuse of glass, measuring accuracy and reproducibility), the organization of a measurement service (working procedure, working period, cost), and the application in radiation monitoring (routine and accidental dosimetry, long-time dosimetry, activation dosimetry). Finally, some possibilities of further improvements are given. (15 figures, 5 tables) (auth)

28198 NEW DEVELOPMENT AND ASPECTS IN PHOSPHATE GLASS DOSIMETRY. Piesch, Ernst (Karlsruhe Nuclear Research Center, Ger.). pp 188-212 of Radiation Dosimetry. Vol. 2. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

In recent years a new method of differential fluorescence measurement was developed by which the glass is continuously scanned and a differential fluorescence intensity is measured and recorded directly as a function of the glass depth. By the new technique the radiation quality (10 keV to 600 keV) and the direction of the radiation incidence can be determined. As a result of extensive calibration exposures and phantom measurements, new aspects of phosphate glass dosimetry are discussed, in particular, the evaluation of radiation quality, the analysis of mixed radiation fields, the indication of the direction of the radiation incidence for frontal exposure and for exposure from behind, and the direct indication of the absorbed dose in the interesting critical organs using an energy-independent dosimeter with reduced influence of body orientation to radiation incidence. The advantages of the new dosimeter system are briefly discussed and compared to other dosimetric systems for personnel monitoring. (20 figures, 2 tables) (auth)

28199 DIRECTIONAL DEPENDENCE OF EXPOSURE MEASUREMENTS AND THE EVALUATION OF EFFECTIVE ENERGIES OF MEDIUM ENERGY X-RAYS BY FILM BADGES. Paic, V.; Paic, M. (Univ., Zagreb, Yugoslavia). pp 217-23 of Radiation Dosimetry. Vol. 2. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

The directional dependence of exposure measurements of medium-energy x rays by film badges was investigated. The effective

energies ranged from 23 to 138 keV, and the badges were exposed at angles from 0 to 80° Fractional photographic densities are plotted as a function of angle of incidence, and the results are discussed from the standpoints of dose measurement and evaluation of the effective energy to which the film was exposed. (3 figures, 4 tables) (R.W.R.)

28200 EVALUATION BY COMPUTER OF THE SURFACE INCIDENT DOSE ON THE LARGE SIZE FILM DOSIMETER. Bojtor, Ivan; Illes, Agnes (National Research Inst. for Radiobiology and Radiohygiene, Budapest. Telecommunication Industry Economic and Computer Center, Budapest). pp 224-33 of Radiation Dosimetry. Vol. 2. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

The value of the concept of surface incident dose is pointed out. The theory of film evaluation is discussed, and the flow chart of a computer program for calculating the surface incident dose is given. The results of the surface incident dose on a film exposed during gastric x-ray examination are tabulated. (3 figures, 1 table) (R.W.R.)

28201 HEALTH PHYSICS INSTRUMENTATION AND SYSTEMS AT THE BORIS KIDRICH INSTITUTE: ACHIEVEMENTS AND TRENDS. Muzdeka, S.; Koturovic, A.; Sobajic, M.; Smelcerovic, M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 234-60 of Radiation Dosimetry. Vol. 2. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

Instruments using new electronic components for measuring exposure rate, radioactive contamination, and sample activities are described. The basic concepts of these instruments are presented, and some interesting details are pointed out. Possibilities for developing complex measuring systems employing the above instruments are also described. Trends of development with regard to new technological solutions are discussed. (17 figures, 4 tables) (R.W.R.)

28202 UNIT FOR DOSIMETRIC INSTRUMENTS CALIBRATION. Lolic, B.; Smelcerovic, M.; Cirilov, B. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 261-8 of Radiation Dosimetry. Vol. 2. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

The primary technical aspects of a calibration unit for dosimeters, such as the construction and disposition of the radiation sources and the construction of collimators, are presented. The effects of filters and reflectors are analyzed. Basic operational principles are given. The chamber used and the electronic circuits for measurements of the dose rate are discussed. (7 figures) (R.W.R.)

28203 NEUTRON DOSIMETRY AND SPECTROMETRY BY MULTISPHERE TECHNIQUES: PRESENT STATE OF S. E. S. R. STUDIES. Benezech, G.; Bricka, M.; Dolias, M. (CEN, Cadarache, France). pp 269-80 of Radiation Dosimetry. Vol. 2. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

Neutron dosimetry and spectrometry measurements were made with spheres 2 to 12 in. in diameter; various methods of analysis were used, and no significant differences were found. Kerma values given by moderating spheres and other measurement techniques are compared. Response curves for spheres of various sizes for neutrons from 5 to 600 keV are given. Neutron spectra obtained with various detectors used with moderating spheres are also shown. (9 figures, 5 tables) (R.W.R.)

28204 CALCULATIONS OF NEUTRON DOSIMETER READINGS FOR DIFFERENT SPECTRA. Makra, S. (Central Research Inst. for Physics, Budapest). pp 281-7 of Radiation Dosimetry. Vol. 2. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

In order to get a clear picture on the possible use of neutron dosimeters and the correction factors to be applied, the reading of different dosimeters was calculated for several spectra of reactor neutrons passing through shielding walls of different materials and thicknesses and compared with actual doses. Spectra considered were a fission spectrum and the spectrum of a light-water-moderated, 10% enriched U reactor assembly: both were modified by shields of water, polyethylene, concrete, iron, lead, concrete + boron, and concrete + iron. Dose rate calculations were performed for a Bonner-sphere Rem counter and a DNA-1-type counter; a slow-neutron scintillation counter; and nuclear track detectors. (8 figures) (R.W.R.)

28205 DEVELOPMENT AND USE OF LITHIUM BORATE FOR THERMOLUMINESCENCE DOSIMETRY. Christensen, Poul (Danish Atomic Energy Commission Research Establishment, Risoe). pp 288-97 of Radiation Dosimetry. Vol. 2. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

The characteristics of lithium borate powder for thermoluminescence dosimetry are first discussed. Experiences with solid dosimeters are then reported. The low production cost of thermoluminescent lithium borate, together with a low photon-energy dependence, an uncomplicated response to previous exposures, and a useful dose range up to 1 megarad, makes the phosphor desirable for many applications. Investigations of lithium borate and ^{7}LiF dosimeters for routine and long-term monitoring were carried out. (7 figures, 1 table) (R.W.R.)

28206 MEASUREMENT OF SOLID THERMOLUMINESCENCE DOSIMETERS BY MEANS OF HOT NITROGEN GAS. Boetter-Jensen, Lars (Danish Atomic Energy Commission Research Establishment, Risoe). pp 298-307 of Radiation Dosimetry. Vol. 2. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

The design of a readout system for solid thermoluminescence (TL) dosimeters of different configurations is presented; hot nitrogen gas is used as the heating medium. This method provides a built-in means of reducing the nonradiation-induced TL in the low-dose region. A number of other advantages are listed. Schematic diagrams of the apparatus and electronics are given, as well as glow and response curves for various dosimeters. (7 figures) (R.W.R.)

28207 EXPERIENCE IN ROUTINE PERSONNEL MONITORING WITH SINGLE CRYSTALLINE TL DOSIMETERS (SCTLD). Niewiadomski, Tadeusz; Ryba, Elzbieta (Inst. of Nuclear Physics, Krakow). pp 308-15 of Radiation Dosimetry. Vol. 2. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

The development of TL dosimeters employing single crystals of LiF(Mg,Ti) is described; they are convenient to use, have good energy response, and can be extended to measurements in the millirem range. Drawings for the special hot-nitrogen reader are included; the reader can process two dosimeters per minute. The advantages of TL dosimeters over classical monitoring methods are pointed out. (6 figures) (R.W.R.)

28208 SELECTION OF HEATING CYCLES FOR THERMOLUMINESCENT DETECTORS. Kudelin, K. M. Meas. Tech. (USSR) (Engl. Transl.): 14: No. 9, 1404-7(Sep 1971).

Translated from Izmer. Tekh.; 14: No. 9, 74-5(Sep 1971).

The integral reading method and the amplitude reading method for thermoluminescent dosimeters are discussed, and results of studies of two constant-rate heating methods are given. In the first method studied, power is supplied to the heating element after the dosimeter is placed on the heating element; in the second method, the dosimeter is placed on the heating element after it has been heated to a constant temperature. The first method was found to give a higher reproducibility than the second. (W.H.K.)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 27797, 28069, 28255, and 29611.

28209 (AD-733979) NEUTRON SPECTROMETER USING ORGANIC SCINTILLATORS. Final Report. Jones, D. W.; Toms, M. Elaine (Naval Research Lab., Washington, D. C.). 10 Nov 1971. 73p. (NRL-7324). NTIS.

Organic scintillation detectors are useful for neutron spectroscopy because pulses induced by gamma rays and those induced by neutrons can be distinguished by electronic means. Computer analysis can be used to obtain the energy spectrum of the neutrons from the measured recoil-proton pulse-height distribution. A practical neutron spectrometer with improved electronic circuitry for pulseshape discrimination is described. A detailed study of the interaction of neutrons with the scintillator is presented in re-

lation to pulse-height analysis. A computer program that uses a straightforward method of pulse-height analysis is given in FORTRAN with suggestions for adaptation for use on a small computer. Spectrometer applications are presented for measuring neutron spectra of monoenergetic neutrons, radioactive neutron sources, scattered neutrons and neutrons from a photonuclear reaction, and for detection of fission neutrons. (auth) (NTIS)

28210 (ARH-2021) Ge(Li) IV ^{239}Pu PACKAGE COUNTER OPERATING AND SERVICING PROCEDURES. Zimmer, W. H. (Atlantic Richfield Hanford Co., Richland, Wash.). Mar 1971. Contract AT(45-1)-2130. 25p. Dep. NTIS.

The Ge(Li) IV is a passive plutonium-239 package counter system capable of detecting and quantitatively analyzing a wide weight range of plutonium-239 in any standard Hanford waste container in compliance with and exceeding waste disposal objectives of less than eight microcuries plutonium-239 kilogram ±30% at the 95% confidence level. The packages are rotated and oscillated; and the package radiation columnated to compensate for nonhomogeneity. An external radiation source emission is passed through the packages to provide data for radiation self-absorption compensation. Four coaxial Ge(Li) detectors are employed to provide a large area of detecting surface. The 413.7 keV gamma emission of plutonium-239 from within the package and the 355.3 keV gamma emission of an external barium-133 source are pulse-height analyzed and data-reduced under computer program control; the computer reads out grams of plutonium-239 in the package, the computed self-absorption correction, and the precision at the 95% confidence level of both values. (W.H.K.)

28211 (CEA-N-1468) NEUTRON SPECTROMETRY WITH A MULTIPLE DETECTOR SYSTEM. Buxerolle, Michel (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Jul 1971. 35p. (In French). Dep. NTIS (U. S. Sales Only).

Neutron spectrometry with multiple detectors necessitates the resolution of the Fredholm integral equation. Equations of this type are extremely sensitive to measurement errors. Oscillations with negative values, which are physically meaningless, appear in the solutions. The method described leads to physically meaningful results. It is applied to the Bonner sphere spectrometer. (France)

28212 (CEA-N-1506) SARA: A CODE FOR THE ANALYSIS OF SPECTRA RECORDED BY Ge-Li SPECTROMETERS. L'homme, Alain (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec 1971. 83p. (In French). Dep. NTIS (U. S. Sales Only).

A complete analysis of γ ray spectra can be effected using the SARA code. The code automatically searches for photoelectric peaks, computes the principal characteristics of the peaks (location, surface, and width), and identifies and computes nuclide activities. (France)

28213 (CONF-720404-3) X-RAY ANALYSIS BY PHOTOELECTRON SPECTROMETRY. Krause, Manfred O.; Wuilleumier, Francois (Oak Ridge National Lab., Tenn.). [1972]. 13p. Dep. NTIS.

From International conference on inner shell ionization phenomena; Atlanta, Ga. (17 Apr 1972).

Electron spectrometry is shown to be an excellent method for determining relative and absolute intensities of x-ray emission lines owing to the simple and well-defined relationship between the photo-electron spectrum and the corresponding x-ray spectrum. Energies and widths of lines can also be measured. An appropriate converter, such as the neon atom, acts as intermediary between the two types of spectra; and electrons are dispersed in an electrostatic energy analyzer of well-known characteristics. This type of apparatus has a resolution $\Delta E/E$ of typically 0.1% and covers a photon energy range from about 20 eV to 3000 eV. The new instrument compares favorably with grating and crystal spectrometers in energy resolution and is superior for intensity determinations. It has greater resolution than solid-state detectors and proportional counters but lower detection efficiency. The method is illustrated by a measurement of the Zr L x-ray emission spectrum. (2 figures, 1 table) (auth)

28214 (JAERI-M-4571) COMPUTER PROGRAM FIT FOR FITTING GAMMA-RAY SPECTRUM. Tasaka, Kanji (Japan Atomic Energy Research Inst., Tokyo). Sep 1971. 26p. (In Japanese). NTIS (U. S. Sales Only).

There are many photo-peaks in the γ-ray spectrum of fission products, and the photo-peaks are not usually well separated from one another. The fitting procedure is then necessary to obtain the intensity of each photo-peak from the measured γ-ray spectrum. The computer program "FIT" has been developed for fitting the γ-ray spectrum by the method of least squares. The fitting function is directly made from the measured result of the single photo-peak of the standard source and expressed by one hundred points. Any γ-ray spectrum may be fitted by the program adjusting the height, width and peak position of each photo-peak and then superposing many photo-peaks on the background γ-ray spectrum, which is mainly composed of Compton scattered γ-rays and approximated by the linear function of energy in the program. The maximum number of photo-peaks treated by the program at a time is twenty-one. (auth) (Japan)

28215 (N-71-37959) ALPHA AND X-RAY SPECTROMETERS: APOLLO LUNAR ORBITAL SCIENCE PROGRAM. Final Report. (American Science and Engineering, Inc., Cambridge, Mass.). 23 Sep 1971. Contracts NAS9-9982; NAS9-9983. 11p. (NASA-CR-115216; ASE-2818). NTIS.

A descriptive summary is presented of the design, development, fabrication, testing, checkout, and support activities for delivery of integrated X-ray and alpha-particle spectrometer systems for the NASA Apollo Lunar Orbital Science program. (auth) (STAR)

28216 STABILITY OF SIGNAL PULSE HEIGHT OF SCINTILLATION DETECTORS AND ITS INFLUENCE ON RESULT REPRODUCIBILITY OF SCINTILLATION SPECTROMETERS AND RADIOMETERS. Silar, J. Radioisotopy; 12: No. 2, 245-325(1971). (In Czech).

The influence of some phenomena on the signal pulse height change of scintillation detectors and the influence of some parameters on the signal pulse rate change as measured in the photopeak and plateau of scintillation detectors are discussed on the basis of literature data and experimental work. (auth)

28217 SCINTILLATION SPECTROMETER NONLINEARITY. Sandrik, S.; Kokta, L. Radioisotopy; 12: No. 2, 197-244(1971). (In Czech).

An experimental verification of the nonlinearity of the scintillation spectrometer arrangement and of its individual parts is presented. Based on considerations of the contribution of the photomultiplier, the measured output amplitude dependence on the gamma quantum energy is explained as being mainly the result of energy quanta deformations in the crystal (the Murray-Meyer theory of scintillation efficiency). The spectrum was analyzed on the computer ELLIOT 803B. The output amplitude dependence on the gamma quantum energy was measured for three well-type NaI(TL) crystals 45 × 50 mm in diameter (diameter of the well 18 × 40 mm). The measured deviations L/E from linearity were up to 12% for energies about 100 keV and ca 4% for energies above 1 MeV. (auth)

28218 PHOTOEFFICIENCY OF γ-RAY DETECTION WITH A SEMICONDUCTOR Ge(Li)-SPECTROMETER. Pelekis, L. L.; Pelekis, Z. E.; Taure, I. Ya. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 6, 3-8(1971). (In Russian).

The possibility of using a radium source for the calibration of a lithium-drifted germanium gamma ray spectrometer was investigated. The photoefficiencies of detectors with active volumes of 3.5, 28 and 45 cm^3 in the energy interval of 0.18 to 2.5 MeV were determined. (auth)

28219 IMPROVED ABSOLUTE LIQUID SCINTILLATION COUNTING OF BETA EMITTERS. Klumpar, J. (Nuclear Research Inst., Prague). Czech. J. Phys.; 22: No. 2, 103-8(1972).

A new method for the absolute determination of the activity of beta emitters in liquid scintillators based on the theoretical shape of their spectrum is described and tested with standardized ^{14}C n-hexadecane. (auth)

28220 TIME-OF-FLIGHT SPECTROMETER FOR SLOW NEUTRONS. Stockmeyer, R. (Institut fuer Festkoerperforschung, Juelich, Ger.). Kerntechnik; 14: No. 1, 13-14(Jan 1972). (In German and English).

The operation of the time-of-flight spectrometer for slow neutrons at the FRJ-2 reactor is described in principle, without considering technical aspects. (1 figure) (auth)

28221 DISORDER SPECTROMETER FOR MEASURING DIFFUSE NEUTRON SCATTERING. Bauer, G. (Institut fuer Festkoerperforschung, Juelich, Ger.). Kerntechnik; 14: No. 1, 20-1(Jan 1972). (In German and English).

The experimental requirements for a disorder spectrometer for measuring diffuse neutron scattering are discussed, and a facility allowing simultaneous measurement with up to 63 detectors is described. Mobile counters allow targeted investigation of selected points of interest in the reciprocal space. Moderate energy resolution of scattered neutrons is possible. An example

illustrating the range in the reciprocal lattice of aluminum which can be covered is given. (2 figures) (auth)

28222 HIGH RESOLUTION TRIPLE AXIS NEUTRON SPECTROMETER. Schmidt, H. H. (Institut fuer Festkoerperforschung, Juelich, Ger.). Kerntechnik; 14: No. 1, 17-19(Jan 1972). (In German and English).

The functional design and the neutron-optical specifications of the triple-axis neutron spectrometer developed at Juelich are described. (1 figure) (auth)

28223 NEUTRON BACK-SCATTERING SPECTROMETER. Alefeld, B. (Institut fuer Festkoerperforschung, Juelich, Ger.). Kerntechnik; 14: No. 1, 15-17(Jan 1972). (In German and English).

A neutron crystal spectrometer with an extremely good energy resolution was built at the cold neutron source of the FRJ-2 reactor. The Bragg angle of the monochromator and analyzer is 90°. The energy of incident neutrons is varied by Doppler motion of the monochromator. It is possible to measure energy variations between 3×10^{-8} and 5×10^{-6} eV. (2 figures) (auth)

28224 SPECTROMETRY OF LOW ENERGY IONS WITH SILICON SURFACE-BARRIER DETECTORS. Bogdanov, G. F.; Maksimenko, B. P. At. Energ. (USSR); 32: No. 1, 66-8(Jan 1972). (In Russian).

Amplitude characteristics and energy resolution of surface-barrier silicon detectors were investigated at 18°C for the following ions at energies of 20 to 200 keV: $^{1}H^{+}$, $^{4}He^{++}$, $^{7}Li^{+}$, $^{12}C^{++}$, $^{14}N^{++}$, $^{16}O^{++}$, and $^{40}Ar^{++}$. For the ions tested the amplitude–energy relation was linear. The p-type silicon detectors in circuitry was characterized by a "cutoff" and a "full width at half maximum" which were helpful in evaluating the data. The presence of a significant amplitude defect for heavy ions suggests the possibility of using surface barrier Si detectors for rough mass analysis. (3 figures) (K.S.W.)

28225 SEMICONDUCTOR DETECTOR WITH AN ANTICOINCIDENCE SYSTEM FOR THE SUPPRESSION OF BACKSCATTERED BETA RAYS. Petersson, L. (Tekniska Hoegskolan, Lund, Sweden). Phys. Scr.; 4: No. 1-2, 15-21(1971).

A lithium-drifted silicon semiconductor detector (LIDS) and a plastic scintillator are operated in anticoincidence in a measuring arrangement with small energy distortion. With this measuring arrangement the whole energy distortion in the semiconductor β-spectrum cannot be eliminated, but the part of the distortion that depends on backscattering is strongly suppressed. This gives an improvement of the energy resolution. Fermi-Curie plots become more linear and the maximum energies, determined by them, more correct. The spectrometer was tested by measuring the β-spectra from ^{207}Bi, ^{137}Cs and ^{59}Fe. The measurements show that the method is applicable even to β-sources giving γ-radiation and when the lifetime of the daughter nucleus is short. As by-results some measuring data are obtained, upon which the distortion effect has a negligible influence. (auth) (Sweden)

28226 EXTERNAL STANDARDIZATION OF LIQUID SCINTILLATION SAMPLES. (to Nuclear-Chicago Corp.). British Patent 1,264,186. 16 Feb 1972. Priority date 20 Sep 1968, United States.

A coincidence system to be used with an external standard radiation source for calibration of the spectra from a liquid scintillation spectrometer is described. (W.H.K.)

28227 BEAM OPTICS STUDIES USING THE MONTE CARLO METHOD. Suarez, A. A.; Mazzilli, E.; Coutinho, F. A. B. (Instituto de Energia Atomica, Sao Paulo, Brazil). An. Acad. Brasil. Cienc.; 43: No. 2, 345-56(30 Jun 1971).

A computer program using the Monte Carlo method was developed to calculate the line profile and resolution of magnetic spectrometers (flat type) for charged particles. The program also gives information about the solid angle and transmission of the spectrometer as well as the particle distribution in the focal plane. (auth)

28228 ANALOG DEVICE FOR THE MEASUREMENT OF THE ACTIVITY OF VARIOUS ISOTOPES IN A MIXTURE. Businaro, T.; Malosti, D.; Rinonapoli, C. Volpe (CNEN, Rome). pp 776-92 of XI International Automation and Instrumentation Conference. Vol. 1. Milan; Federazione delle Associazioni Scientifiche e Technische (1970). (In Italian).

From eleventh international automation and instrumentation conference; Milan, Italy (23 Nov 1970). See CONF-701145-(Vol. 1).

At the exit of a γ ray detector (scintillation or semiconductor) which is located near a source that emits monoenergetic photons, there is an associated energy width. This width is directly proportional to the energy of the incident photons. A method is suggested which provides continual control sufficient for most purposes by means of fairly simple apparatus which is economical in design. Six channels are connected to a normalization amplifier, each channel being essentially a differential discriminator connected to a velocity counter. A prototype has been designed which has furnished good results on specimens of irradiated uranium. Modifications are being made for improving the service, particularly as concerns the precision and the flexibility of the application. The spectra of three isotopes: ^{22}Na, ^{137}Cs, and ^{60}Co, were determined both separately and together. (K.S.W.)

28229 FAST QUALITATIVE AND QUANTITATIVE DETERMINATION OF ENVIRONMENTAL RADIOACTIVITY BY Ge(Li) GAMMA SPECTROMETRY. Shafrir, N. H. (Technion-Israel Inst. of Tech., Haifa); Laichter, J.; Gilat, E. pp 291-300 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

A common problem in the determination of environmental radioactivity is the measurement of several components in a complex mixture of radionuclides where concentrations may differ widely. As most radionuclides emit one or more gamma photons during the course of their decay, gamma spectrometry can be applied. Until recently, the NaI(Tl) scintillator was the mainstay of all gamma spectrometers. However, its poor resolution often made necessary tedious chemical separations of the radionuclides sought. The properties demanded of a low-level gamma-spectrometry system for a rapid method of determination are lowest possible background, high efficiency, and sharp resolution. The introduction of large-volume solid-state detectors to gamma spectrometry satisfies these requirements. Rapid and accurate qualitative and quantitative determinations of environmental radioactivity can be performed down to the pCi level by applying high-resolution low-level Ge(Li) gamma spectrometry. A suitable system, based on a heavily shielded 42-cm^3 Ge(Li) crystal serving as the main detector and operating in anticoincidence with a large plastic scintillator assembly, was successfully applied for determinations of environmental radioactivity. The sensitivity of the system permits direct, unambiguous analyses of up to 200-cm^3 solid and liquid environmental samples for many radionuclides at levels down to 0.02 pCi per gram, depending on the gamma energy. Time-consuming chemical separations before measurement are unnecessary in most cases. As a result, sample preparation for such measurements becomes a simple and rapid procedure. Solid samples of plant and animal origin are prepared by drying, grinding into fine powder, and, where necessary, by compression up to a density of about 2. The latter procedure enhances counting efficiency and should be adopted when relatively low-level measurements are performed. By this procedure of sample preparation, losses of radioelements by the usual ashing technique are prevented. Solid samples of mainly inorganic origin can be prepared in a similar manner, whereas liquid samples are measured without physical pretreatment in a standard plastic container proportionate to the system's geometrical setup. (5 figures) (auth)

28230 ROLE OF LOW-BACKGROUND BETA-RAY SPECTROMETERS FOR RAPID ASSAY OF ENVIRONMENTAL SAMPLES. Maruyama, T.; Tanaka, E.; Hiramoto, T. (National Inst. of Radiological Sciences, Chiba, Japan). pp 357-71 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

The role of low-background beta-ray spectrometers ("Pico-Beta") for rapid and simple measurement of environmental radioactivity is reviewed. The detector consists of a plastic scintillation counter and window G–M counter placed in the hollow of the scintillator, and the scintillation pulses coincident with the G–M counter pulses are recorded by a pulse-height analyzer. The pulse-height distribution is obtained in either a logarithmic or linear energy scale. The background counting rate of the spectrometer is extremely low and stable. It is possible to use this spectrometer for the following measurements: low-level counting of a known nuclide, identification of an unknown nuclide, checking of the radiochemical purity of a sample, simplification of chemical separation, analysis of a mixture of radioisotopes which cannot be separated chemically, determination of equilibrium ratio, and rapid determination of a short-lived nuclide. (11 figures) (auth)

28231 PORTABLE BATTERY-POWERED NUCLEAR SPECTROMETER FOR CONTAMINATION MEASUREMENTS. Schon-

ken, P. (Catholic Univ. of Louvain, Heverlee, Belg.). pp 471-7 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

In a contamination incident it is important to know as quickly as possible, and preferably on the spot, the nature and approximate quantity of the radioactive nuclei involved. These data make it possible to decide upon a suitable decontamination procedure. Mostly the detection can be done by scintillation spectrometry of emitted gamma rays or of beta particles. A small battery-powered portable spectrometer was developed with the following features: it produces a visible "analog" spectrum that can be accumulated on a fast photographic paper (Polaroid type); an interpretable gamma spectrum of a 1 mCi source from a 3 in. × 3 in. sodium iodide crystal can be obtained in 1 min; it has up to eight separate channels in which numbers of counts of easily adjustable parts of the spectrum can be accumulated simultaneously. The counts in the channels can be read directly for evaluating amounts of radioactive substances after suitable calibration of the probe; the electronic circuits are selected for low power consumption and include a stable photomultiplier power supply needing less than 50 mW; the instrument can operate for more than 10 h; it is simple, lightweight, and inexpensive. (auth)

28232 RAPID DETERMINATION OF FISSION PRODUCTS IN THE SURROUNDINGS OF REACTORS. Kriks, H.-J.; Rasp, W.; Siegel, V. (Physikalisch-Technische Bundesanstalt, Brunswick). pp 479-86 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

A procedure is described which allows not only a rapid and reliable identification of fission products released into the air, but also the determination of their activity concentrations. The apparatus can be transported in any car and is even ready for operation on a bicycle trailer in difficult terrain. It consists of an air dust sampler with high throughput (60 m^3/h), fed by a portable independent power supply, and a battery-powered 128-channel pulse height analyzer with a NaI(Tl) scintillation detector (38 mm × 38 mm dia) in a lead shielding. The number of pulses in each channel of the analyzer can be read from an indicator by moving a marker across the gamma spectrum. The correlation of the channels and the energy of the gamma rays is achieved with the help of radioactive samples with known gamma-ray energy. The stability of the channels during operation is checked before and after each measurement by a test sample. The efficiency was calibrated with different, frequently occurring, fission products whose activity concentration in the air was known and which were deposited on a filter by an air dust sampler at a known throughput. The activity concentration of the fission products amounted to even multiples of their maximum permissible concentration according to Appendix II of the First Regulation on Protection against Radiation. After the measurement of the gamma-ray spectrum of the filter deposit, the marker is adjusted to the maximum of a gamma-ray line, identified as originating from a fission product, and one obtains on the indicator a reading that is proportional to the activity concentration of the known nuclide. The conditions of measurement in operation have to be identical with those of the calibration. With this equipment, after a sampling time of 10 min and a measuring time of 20 min, activity concentrations of different fission products can be reliably detected in the order of magnitude of a tenth of the maximum permissible concentration. (6 figures) (auth)

28233 SEMICONDUCTOR DETECTORS. IMPORTANCE OF AVALANCHE DETECTORS. Blanc, D.; Peyre-Lavigne, A. (Univ., Toulouse). pp 126-58 of Radiation Dosimetry. Vol. 2. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

The general ideas of semiconductor junction detectors are first discussed. The electrical characteristics of the p–n junction are described, and the fabrication of various types of detectors (diffused p–n junctions, surface-barrier detectors, Li-drifted dioxides, and ion-implanted junctions) is reviewed. The more specialized subject of Si avalanche detectors and the mechanisms involved in their operation is taken up; the noise of a detector functioning at avalanche conditions is dealt with in some detail. (16 figures, 6 tables) (R.W.R.)

High Energy Physics Instrumentation

28234 (EFI-ME-1(71)) ON THE POSSIBILITY OF THE CHARGED-PARTICLE TRACK DRIFT COMPENSATION IN THE WIDE GAP SPARK CHAMBER. Avakyan, K. M.; Aivazyan, R. B.; Matevosyan, E. M. (Akademiya Nauk Armyanskoi SSR, Erevan. Institut Fiziki). 1971. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

The method of supplying the wide gap spark chamber with high voltage rf pulses has been realized. It is shown that in an alternating field the spark track displacement from the true trajectory of the charged particle due to avalange drift is absent. An HV generator supplying the rf pulse from 3 to 8 Mc is described. (auth)

28235 (JINR-P1-6245) ELECTRON METHOD OF PARTICLE DETECTION IN TWO-PHASE LIQUID-GAS SYSTEMS. Dolgoshein, B. A.; Kruglov, A. A.; Lebedenko, V. N.; Miroshnichenko, V. P.; Rodionov, B. U. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 34p. (In Russian). Dep. NTIS (U. S. Sales Only).

The operation principle and characteristics of two-phase electron detectors of ionizing radiation, filled with liquid argon, are described. Particle detection in various types of similar detectors described is based on the electrostatic emission of the particle track electron image from the liquid phase to the gas one. The possibility is shown of filmless detection of ionizing particle tracks in liquid argon by means of a system of wire electrodes, located in a gas phase. Proportional gas multiplication at 100% particle detection efficiency takes place near the surface of these electrodes. (auth)

28236 (N-72-13632) COMPARISON OF THE ENERGY RESPONSE OF AN IONIZATION SPECTROMETER FOR PIONS AND PROTONS. Jones, W. V.; Verma, S. D. (Louisiana State Univ., Baton Rouge. Dept. of Physics and Astronomy). [1971]. 5p. (NASA-CR-124729; HE-36). NTIS.

An ionization spectrometer consisting of a sandwich of iron absorbers and plastic scintillation counters was used to measure the energy of pions and protons in the interval 10 to 1000 GeV. For the limited energy interval of 10 to 40 GeV, pions and protons were identified by an air Cherenkov counter. Interactions in carbon were studied in a multiplate cloud chamber placed between the Cherenkov counter and the spectrometer. Knowledge of these interactions were used in conjunction with a Monte Carlo simulation of the cascade process to study differences in the response of the spectrometer to pions and protons. (auth) (STAR)

28237 (NP-19146) EXPERIMENTAL METHODS OF HIGH-ENERGY PHYSICS. Bienlein, J. K. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). [ndl. 181p. (In German). Dep. NTIS (U. S. Sales Only).

The following selected measuring instruments and trends for experimental techniques in high-energy physics are discussed: a large bubble chamber (BEBC), a large installation for counter experiments (Omega project), utilization of on-line computers for counter experiments and for evaluation of bubble chamber pictures, and instruments for polarization experiments as well as for storage ring experiments. A survey of CERN and DESY outlines properties of the accelerators available there which are of interest to the researcher and describes several experiments. The lectures require knowledge about principles of scintillation counters, Cherenkov counters, and fast electrons, as well as bubble chambers and accelerators. Emphasis is placed on the utilization of these instruments in modern experimental arrangements. (67 figures, 4 tables) (tr-auth)

28238 TRACK-MATCHING PROGRAM FOR BUBBLE CHAMBER PHOTOGRAPHS. Bastien, P. L. (Massachusetts Inst. of Tech., Cambridge, Mass.); Snyder, J. N.; Pless, V. Comput. Phys. Commun.; 2: No. 7, 394-419(Dec 1971).

A computer program, MATCH, for matching and labeling bubble chamber particle tracks photographed simultaneously by three cameras with three views is described. (W.H.K.)

28239 LATENT IMAGE DISTRIBUTION IN NUCLEAR EMULSIONS UNDER THE ACTION OF A PULSED ELECTRIC FIELD. Akopova, A. B.; Babakhanyan, E. A.; Garibyan, G. M.; Magradze, N. V.; Melkumyan, L. V. (Erevan Physics Inst.). Dokl. Akad. Nauk SSSR; 200: No. 3, 617-19(21 Sep 1971). (In Russian).

Emulsion layers 400 μ thick were exposed to a 3 GeV electron beam in a synchrotron while being subjected to a pulsed electric field of intensity 10^5 V/cm. The duration of a pulse was 5 to 10 sec, and the frequency was 80 to 100 pulses/sec. A frequency of 100/sec caused complete loss of relativistic electron tracks. Pulsed fields promoted migration of photolytic silver in the latent image and the silver admixture centers from the surface of AgBr

microcrystals and their localization in the depths of the grain. (K.S.W.)

28240 BIG EUROPEAN BUBBLE CHAMBERS. Musset, Paul (Ecole Polytechnique, Paris). Ind. At.; 15: No. 5, 13-24 (Nov 1971). (In French and English).

The three giant bubble chambers recently constructed in Europe are described. Their expansion systems, magnets, illumination systems and optics are compared. (France)

28241 TWO TYPES OF MAGNETOSTRICTIVE WIRE READOUTS FOR SPARK CHAMBERS. Buchanan, C. D.; Everhart, G.; Goldblatt, I. D.; (and others) (Univ. of Pennsylvania, Phildelphia). Rev. Sci. Instrum.; 43: No. 4, 603-4(Apr 1972).

Two types of magnetostrictive wire readouts are described. One is a multiwire nickel arrangement for use in magnetic fields (~200 G). The other type employs a dual pickup on a single Remendur wire and removes uncertainties in spark location which are caused by spark width and spark formation time. (auth)

Radiometric Instruments

28242 PROFILE INTEGRATION TYPE BETA RAY THICKNESS GAUGE. Shimizu, Masami; Sawaguchi, Mutsuo; Okamoto, Eisuke (Fujitsu Ltd., Tokyo). Fujitsu; 22: No. 3, 477-93(May 1971). (In Japanese).

Thickness gages of the profile integration type perform thickness measurements by moving the radiation source and detector in the direction of the sheet width, to obtain the non-uniformity of sheets of definite width. The integration type profile thickness gages average the profiles measured as frequently as possible in a short time. The effect of the disturbances is reduced to $1/\sqrt{N}$ by averaging the profiles measured N times. The profile integration thickness gages of Fujitsu Co. designed from the above consideration measure plastic sheets ranging from 10 to 1,000 g/m^2 thickness with an accuracy of ±1% with approx. 1,000 mCi of ^{85}Kr. It has 400 channel memory and CRT display for data analysis. The most difficult problem in designing the gages was that of noise. It was solved by adopting a method to isolate IC circuits from power circuits by combining photo-relays with a DC–DC voltage converter. (Japan)

28243 ELECTRONIC FILLING HEIGHT MEASURING TECHNIQUE. REVIEW. Boehme, J. Electronik (Munich); 20: No. 2, 43-8(1971). (In German).

A review on level indicators is presented to point out the importance of the choice of method and instrumentation configuration for a particular application. Capacitive, conductive, ultrasonic, radiometric, electromechanical, and electromagnetic methods are discussed. (W.H.K.)

28244 MEASURING APPARATUS. Wilkinson, Bernard Hall (to Rolls-Royce Ltd.). British Patent 1,264,729. 23 Feb 1972. Filed 8 Sep 1970.

An x-ray thickness gage that uses a focused electron beam for x ray production in the sample and an x ray detector on the side of the sample opposite to the incident electron beam is described. (W.H.K.)

28245 UP-TO-DATE TECHNOLOGICAL NEUTRON MODERATION MOISTURE GAUGE AND SOME EXPERIENCES OF ITS APPLICATION. Rozsa, S.; Toth, E. (MTA Izotop Intezete, Budapest). Izotoptechnika; 14: No. 11, 512-18(Nov 1971). (In Hungarian).

In some cases neutron moderation moisture determination proves to be the only method for continuous measurement and control of moisture in industry. The described apparatus, developed by the Institute of Isotopes of the Hungarian Academy of Sciences, can be used to work in various technological lines in industry. (auth)

28246 NUCLEAR INSTRUMENT STANDARDS. Cook, H. L. Jr. (Ohmart Corp., Cincinnati). Advan. Instrum.; 25: Pt. 2, 664.1-5(1970).

From 25th annual conference of the Instrument Society of America; Philadelphia, Pa. (26 Oct 1970).

The organizations that write standards that apply to industrial instruments which utilize nuclear or x radiation are reviewed. Organizations active at the present time are: ANSI, USAEC, USDOT, ISO, IEC and IAEA. The N42 and N43 committees of ANSI are the most active groups in the US. N43 has written two standards—one on particle accelerators and one on sealed sources—and is actively engaged in writing several others. N42 is serving as the liason group with the IEC for standards on gage performance (W.H.K.)

28247 NUCLEAR GAGES APPLIED TO A PRESSURIZED GAS PRODUCER FOR LOCATION OF COAL BED LEVEL AND COMBUSTION ZONE. Friggens, G. R.; Hall, A. W. (Bureau of Mines, Morgantown, W. Va.). Advan. Instrum.; 25: Pt. 4, 804.1-3(1970).

From twenty-fifth annual conference of the Instrument Society of America; Philadelphia, Pa. (26 Oct 1970).

The U. S. Bureau of Mines is applying nuclear methods to monitor the coal bed level and combustion zone of a pilot-scale pressurized gas producer. Detection instruments measure the transmission of cobalt-60 gamma rays through the 56-inch-diameter by 16-foot-high vessel and provide personnel with continuous operating information, including coal bed height, occurrence of voids, location of combustion zone, and accumulation of excessive ash. Smoother, more efficient operation of the producer has resulted in improved gas production. (auth)

28248 POSSIBILITIES AND LIMITATIONS OF NONDESTRUCTIVE DENSITY TESTING. Arand, W. (Univ., Karlsruhe, Ger.). Bitumen, Teere, Asphalte, Peche; 22: No. 5, 213-18(1971). (In German).

The operating principle of radiometric gages for density measurement is discussed, and a ^{226}Ra gage for density measurements of an asphalt roadway is described. (TSS) (INIS)

28249 LEVEL HEIGHT MEASUREMENTS AND CONTROL. Wieser, R. Ind.-Elek. Elektron.; 16: No. 8, 198-201(1971). (In German).

A brief survey is given of the various methods and devices obtainable in Germany. Among others the ^{60}Co-density gage DH 60/2 (Krohne Co.) and a ^{60}Co-relay (Endress and Hauser Co.) for level height measurement of bulk materials are briefly described. (INIS)

28250 RADIOMETRIC MEASUREMENTS IN INDUSTRY. Kosmowski, A. (Frieseke und Hoepfner GmbH, Erlangen, Ger.). Ind.-Elek. Elektron.; 16: No. 19, 478-81(1971). (In German).

A brief survey on the economics and the employment of radiometric thickness and area weight gages in the FRG is presented. Examples include process control during the manufacture of paper, paperboard, plastic foils and plates, metal foils, cold- and warm-rolled metal sheets, wadding, foam material, textiles, asbestos, zinc coating, and coatings in general. (INIS)

28251 MOVING GAMMA-SOURCE SOIL DENSITY GAUGES. Ciftcioglu, O.; Taylor, D. (Univ. of Strathclyde, Scotland). Soil Sci.; 113: No. 1, 13-17(Jan 1972).

A moving source method of measuring soil densities using a backscatter gauge is described in which the source–detector separation (d) is varied to maximize Id^n, where I is the counting rate output of the detector. If d_m = value of d at a Id^n maxima, then $\rho d_m = (n-1)/k$ where k is a constant related to the mean mass absorption coefficient of the soil. Hence, measurement of d_m allows a determination of the density of the soil to be made. The gauge is an improvement of the old fixed d-gauge, a measurement being accomplished in less time, no calibration being necessary and a higher accuracy being possible. Variation of the index (n) to one of a number of pre-set values provides the instrument with a useful flexibility, since for any required density (ρ), n may be chosen to allow a d_m for an Id^n-maximum, within the range of d values available for the instrument to be used. This provision allows a more compact, lighter instrument to be designed. (auth)

Radiation Effects on Instrument Components, Instruments, and Electronic Systems

Refer also to abstracts 28733 and 29996.

28252 (N-71-36443) EFFECT OF RADIATION ON LITHIUM DOPED SOLAR CELLS. Final Report. Whiffen, M. C. (Lockheed-Georgia Co., Marietta). 20 Jul 1971. Contracts NAS7-100; JPL-952586. 116p. (NASA-CR-122943; ER-11150). NTIS.

For Jet Propulsion Lab., Pasadena, Calif.

A description is given of the irradiation of lithium doped p/n solar cells at temperatures of 223, 303, and 253°K. Irradiation was conducted in vacuum and the source was Sr-90 beta particles at a rate of 10 to the 12th power e/sq cm/day. The cells were irradiated to a fluence of 2 × 10 to the 14th power e/sq cm. Conventional n/p cells were included for comparison. Results of the test show that crucible grown lithium cells are superior at 353 K while float zone grown lithium diffused cells are slightly superior

at 303, and at 223 K. Where lithium mobility is very low, conventional n/p cells are superior. (auth) (STAR)

28253 (N-71-36444) RADIATION DAMAGE ANNEALING KINETICS IN LITHIUM-DIFFUSED SILICON SOLAR CELLS. Annual Report. Dresselhaus, M. S. (Massachusetts Inst. of Tech., Cambridge. Center for Materials Science and Engineering). Jul 1971. Contracts NAS7-100; JPL-952936. 25p. (NASA-CR-122987). NTIS.

A model for the annealing kinetics of radiation damage in lithium-diffused silicon solar cells has been developed using a phenomenological approach, whereby the carrier recombination rate is found through use of the Shockley-Read-Hall theory for carrier lifetime. The annealing process is handled through a time-dependent recombination center density according to the kinetic equations of Fang. Even though it appears to be an oversimplification to use a single level of the Shockley-Read-Hall theory and first order kinetics in the Fang theory, these forms are used as a first approximation. With these simplifications, it is feasible to develop a computer program to predict device performance from specified cell characteristics in lithium-diffused silicon solar cells. (auth) (STAR)

28254 (SC-R-722620) IONIZING RADIATION EFFECTS IN MICROWAVE CAVITIES. Chaffin, R. J. (Sandia Labs., Albuquerque, N. Mex.). [1971]. 3p. Dep. NTIS.

Recent studies of the effects of ionizing radiation on microwave Gunn oscillators have neglected the effect of the ionizing radiation on the gas inside the microwave cavities used as part of the oscillator circuit. It is shown both theoretically and experimentally that this effect cannot be neglected above dose rates of 10^8 Rad/sec. (auth)

28255 SILICON SURFACE BARRIER DETECTORS IRRADIATED BY 500 keV TO 1 MeV ELECTRONS. Nakamoto, Shunsuke; Aoki, Takashi; Kawabata, Keishi (Hiroshima Inst. of Tech.). Mem. Chubu Inst. Technol.; 7: No. 12, 127-35(Dec 1971).

The radiation effects on silicon surface barrier detectors by 500-keV, 750-keV, and 1-MeV electrons were investigated using fifty in-house-fabricated detectors of 200 to 1000 Ω-cm resistivities. The changes of reverse current, forward current, depletion layer capacitance, and ^{210}Po alpha spectrum were measured. The reverse current changes in complicated forms with electron fluence. The forward current and the capacitance begin to change at 1×10^{15} cm^{-2}, and the capacitance tends to saturate at 5×10^{16} cm^{-2}. The alpha spectrum begins to degrade at 1×10^{14} cm^{-2}, and double peaks are observed at higher fluences. The detector characteristics are dependent on the total electron dosage, incident electron energy, and detector thickness. These effects mean the formation of trap centers is quite significant in irradiated silicon. (11 figures) (auth)

28256 OBSERVATION OF DAMAGE REGIONS PRODUCED BY NEUTRON IRRADIATION IN LITHIUM-DOPED SILICON SOLAR CELLS. Ghosh, S.; Sargent, G. A. (Univ. of Kentucky, Lexington). J. Mater. Sci.; 7: No. 2, 153-8(Feb 1972).

Regions of lattice disorder produced in lithium-doped float-zone melted n/p-type silicon solar cells by irradiation with monoenergetic neutrons at doses between 10^{19} and 10^{13}/cm^2 were studied. The defect regions were revealed by chemically etching the surface of the solar cells and by observing carbon replicas in an electron microscope. It was found that the defect density increased with increasing irradiation dose and increased lithium content, whereas the average defect diameter was found to decrease. From thermal annealing experiments it was found that in the lithium-doped material the defect structure was stable at temperatures between 300 and 1200°K. This was found to be in contrast to the undoped material where at the lowest doses considerable annealing was observed to occur. The above results are discussed in terms of the theoretical predictions and models of defect clusters proposed by Gossick (J. Appl. Phys.; 30, 1214(1959)) and Crawford and Cleland (J. Appl. Phys.; 30, 1204(1959)). (auth) (UK)

28257 COMPARATIVE RESULTS OF THE NEUTRON IRRADIATION OF DIFFUSED AND ION-DIFFUSED HIGH-FREQUENCY MEDIUM POWER n-p-n SILICON TRANSISTORS. Zarudskii, V. F.; Levitskii, K. B.; Naumenko, V. G.; Ukhin, N. A. Poluprov. Prib. Ikh Primen., Sb. Statei; No. 24, 27-30(1970). (In Russian).

High-frequency silicon transistors of two types were irradiated with neutrons in order to determine a possible difference in radiation stability between them. A distinct difference in fabrication of the two types of n-p-n transistors produced diffusion and diffusion-ionic transistors, respectively, but no difference in the effects of neutron irradiation was detected. (1 figure, 1 table) (K.S.W.)

28258 RADIATION ALLOYING OF POLYMER INSULATION OF LOGGING CABLES FOR HIGH-TEMPERATURE WELLS. Mesenzhnik, Ya. Z. Geofiz. App.; No. 43, 148-53(1970). (In Russian).

Of the currently known insulating materials suitable for use in heat-resistant logging cables, irradiated polyethylene is of particular interest; its properties can be controlled by the conditions and regime of radiation "alloying." Results are presented of an investigation of irradiated polyethylene and other insulating materials, in conditions simulating the temperature-pressure and other regimes of operation of logging cables. With an increase in absorbed dose, the average temperature coefficient of resistance of the insulator and disruptive strength fall off. The critical temperatures are shown for low-density polyethylene irradiated to a dose of 120 mrad, also for polyfluoroethylene resin, at a hydrostatic pressure of 1,200 kg per sq cm. (Geophys. Abstr.)

28259 IRRADIATION EFFECTS IN SUPERCONDUCTING SYNCHROTRON MAGNETS. Brechna, H.; Maurer, W. (Kernforschungszentrum, Karlsruhe, Ger. Univ., Karlsruhe, Ger.). pp 224-7 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Methods for proton radiation dose estimations in magnets are presented, and endangered magnet areas are discussed. Also, the properties of superconducting magnets when exposed to high radiation dose rates are discussed. (W.H.K.)

28260 RADIATION DAMAGE OF SILICON PHOTODETECTORS FOR STAR SENSORS IN SATELLITES. Braeunig, D.; Meinhardt, O.; Spencker, A.; Wagemann, H. G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Angew. Phys.; 32: No. 5-6, 313-18(1972). (In German).

Several examples of different devices [663 (ENL); 602-5 D (ENL); PIN-6 LC (UDT)] were submitted to electrical and optical investigations (especially noise and dark-current, relative spectral sensitivity, and photoelectric current generated by means of Johnson light) before and after irradiations by X-rays (100 keV energy limit) and electrons (600 keV and 1.5 MeV). The results are discussed and evaluated concerning the different mechanisms of the devices. (auth)

28261 X-RADIATION EFFECTS ON MOS DEVICES AT ROOM TEMPERATURE. Kreutz, E. W. (Technische Hochschule, Darmstadt, Ger.). Z. Angew. Phys.; 32: No. 4, 280-6(1971).

Changes of leakage current and of transfer characteristics have been measured during X-irradiation in commercially available n-channel field effect transistors of the metal-oxide-semiconductor configuration. For unencapsulated devices the leakage current at first increases and after passing a maximum decreases with irradiation time. Hermetically sealed transistors only show negative changes of leakage current. The partial relaxation and the thermal annealing characteristics of X-ray induced changes are presented. During X-irradiation, the charge in the oxide is altered and new surface states at the $Si-SiO_2$ interface are created. Irradiation under different atmospheres gives information about the concerned surface states. (auth)

28262 AMORPHOUS ALLOY RESISTANCE THERMOMETER DEVELOPMENT. Tallman, Charles R. (Los Alamos Scientific Lab., N. Mex.). Advan. Instrum.; 25: Pt. 2, 619.1-6(1970).

From twenty-fifth annual conference of the Instrument Society of America; Philadelphia, Pa. (26 Oct 1970).

A unique resistance thermometer with enhanced sensitivity at cryogenic temperatures has been developed. This thermometer uses an amorphous $Pd_{75}Si_{20}Cr_7$ alloy that has high resistivity at 4°K and decreasing resistivity with increased temperature up to 600°K. The sensitivity is greater than that of platinum below 20°K. This thermometer was developed for use in a nuclear environment and is expected to have little or no sensitivity to radiation effects of fast-neutron fluences of 10^{17} to 10^{18} nvt $E_n > 1$ MeV and to γ-heating rates of 10 ω/g. The design concepts, theory and experimental results are discussed. (auth)

28263 SELECTION OF TRANSDUCER DESIGN APPROACHES FOR STRAIN MEASUREMENTS IN A HIGH RADIATION ENVIRONMENT. Figenbaum, E. K.; Chambers, G. M. (Westinghouse Electric Corp., Pittsburgh). Advan. Instrum.; 25: Pt. 2, 627.1-10(1970).

From twenty-fifth annual conference of the Instrument Society of America; Philadelphia, Pa. (26 Oct 1970).

A systematic design approach for the selection of a transducer design for monitoring strain measurements in a high radiation

environment is described. A specific case study, the support stem axial load measurement for the NERVA reactor, is presented to show the implementation of this approach. (W.H.K.)

28264 METHODS OF INCREASING RADIATION RESISTANCE OF BORON TRIFLUORIDE COUNTERS. McKnight, James Alan (to United Kingdom Atomic Energy Authority). British Patent 1,267,196. 15 Mar 1972. Filed 3 Apr 1968.

BF_3 neutron counters, when used in nuclear reactors, undergo substantial gamma irradiation and it has been found that they experience permanent deterioration after gamma doses of about 1000 R at 10 to 20 R/hr. The method claimed for increasing resistance to damage is to subject the counter, before use, to a gamma dose of at least 10^6 R at 10^5 R/hr or more whilst applying a polarizing voltage. (UK)

28265 INFLUENCE OF NEUTRON IRRADIATION ON THE OPERATION OF SURFACE-BARRIER FISSION FRAGMENT DETECTORS. Seregina, E. A.; Semenova, N. N.; Kuz'minov, B. D. At. Energ. (USSR); 32: No. 1, 70-2(Jan 1972). (In Russian).

The maximum allowable fast-neutron doses (E_n = 1.5, 2.8, and 15 MeV) at which silicon surface-barrier detectors would still function satisfactorily were determined. The relative loss of charge caused by fission fragments was studied as a function of neutron dose. The time-characteristics of counters were examined before and after neutron irradiation: the time of charge collection was increased to 150 to 200 ns. It was concluded that low-resistance Si surface-barrier detectors will continue to function in spectrometric studies after integral radiation doses up to 10^{13} fast neutrons/cm^2 (1.5 and 2.8 MeV), or up to 5×10^{12} n/cm^2 at 15 MeV. High-resistance Si (2,000 to 3,000 ohm · cm) should not be used for the spectrometry of fission fragments in the presence of neutrons. (3 figures) (K.S.W)

Miscellaneous Instruments and Components

Refer also to abstracts 28136, 30201, 30240, 30395, 30405, and 30483.

28266 (CEA-N-1508) AN AUTOMATIC CENTRALIZER FOR MONITORING ATMOSPHERIC PARAMETERS. Monet, Roger; Peulve, Jacques; Cartoux, Gerard (Commissariat a l'Energie Atomique, Saclay (France), Centre d'Etudes Nucleaires). Dec 1971. 33p. (In French). Dep. NTIS (U. S. Sales Only).

The radiological protection service of the Centre d'Etudes Nucleaires de Saclay utilizes an automatic information centralizer for atmospheric measurements. It facilitates the monthly presentation of results, climate studies on the site and studies of the fine structure of the biosphere. The assembly, which is adapted for both routine measurements and nonroutine projects, can supply information from some or all of its 32 probes. Although the system is adapted to information storage in view of a computerized treatment, the measurements can be instantaneously displayed and the evolution of atmospheric phenomena can be followed. (auth)

28267 (JINR-P13-6232) ZERO-CROSSING DETECTOR. Boreiko, V. F.; Grebenyuk, V. M.; Zinov, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 7p. (In Russian). Dep. NTIS (U. S. Sales Only).

A circuit, designed at the Laboratory of Nuclear Problems (JINR), for separation of the moment of passing through the zero level of the bipolar form signal is described. A tunnel diode with the hysteresis value defined by a negative feedback is used as a separation element. The triggering threshold of a tunnel diode and its return into the initial state are regulated separately. (auth)

28268 (UCRL-73578) ACCELEROMETER ISOLATOR. Comfort, William J. (California Univ., Livermore. Lawrence Livermore Lab.). 18 Feb 1972. 10p. (CONF-720312-1). Dep. NTIS.

From Underground nuclear test measurement symposium II; Menlo Park, Ca. (21 Mar 1972).

A mechanical clipper for isolating accelerometers from unwanted high-frequency, high-amplitude inputs in effects tests at the Nevada Test Site was successfully designed and tested. The clipper, which behaves as an elastic, plastic acceleration-input limiter, is mounted between the accelerometer and the surface whose acceleration is to be measured. The clipper is designed to allow predetermination of the maximum acceleration amplitude to which the accelerometers will respond. In addition, it significantly reduces ringing of the accelerometers. (6 figures) (auth)

28269 (UCRL-73637) STRUCTURAL RESPONSE INSTRUMENTATION TECHNIQUES AT NTS. Vollmer, Donald W. (California Univ., Livermore. Lawrence Livermore Lab.). 3 Mar 1972. 29p. (CONF-720312-7). Dep. NTIS.

From Underground nuclear test measurement symposium II; Menlo Park, Ca. (21 Mar 1972).

The Effects Group of LLL's Weapons Division is engaged in extensive structural response studies of current weapon systems. These studies include participation on effects tests at NTS, normally on a systems or interagency level. The data taken on these tests are typically the strain, acceleration, and temperature characteristics of the system and fall in the frequency range below 10 kilohertz with amplitudes of a few millivolts. From an electrical standpoint, the major problems encountered on these tests are gage damage and recording system overload generated by the zero-time noise. This noise is divided into three categories: gamma-induced charge generation in the cables, noise coupled from the experiment structure, and noise coupled from adjacent cables. The response of the cabling systems used in the field is significant in determining the characteristics of this noise at the input of the recorder. Also important is the grounding technique used in the instrumentation system; thus, these systems are characterized by their grounding scheme. Since the noise source is primarily contained within the pipe, prime consideration is directed to the portion of the experiment system including the gage and the cabling within the test chamber. Techniques important in this area are divided into four categories: symmetry or balance, shielding, isolation, and gage selection. Ideally, the symmetry should be true for both electromagnetically coupled noise and for direct radiation deposition on the gage and cabling. The shielding category includes gage shielding and cabling inside the experiment pipe. The isolation category includes gage application techniques and tests and isolation measurements in the field. Finally, gage selection is concerned with choosing both a measurement technique and gage most likely to provide the system engineer with the needed data while surviving the NTS environment. (10 figures) (auth)

28270 (UCRL-73659) DESIGN OF A PASSIVE CRACK DETECTOR SYSTEM. Parker, Robert (California Univ., Livermore. Lawrence Livermore Lab.). 18 Feb 1972. 14p. (CONF-720312-6). Dep. NTIS.

From Underground nuclear test measurement symposium II; Menlo Park, Ca. (21 Mar 1972).

An inexpensive, passive crack detector system was developed to determine how soon after exposure to radiation a mechanical component would crack. The system was designed so that switches were activated, initially from the radiation and later from the g loading associated with the experiment. This allowed current from cadmium batteries to flow through a conductive element on the surface of the test component. An interruption of the current by the formation of a crack was recorded on a passive current integrating device in series with the conductive element. Upon recovery, the records may be visually inspected to determine when, if any, cracks occurred. The entire package, including spring loaded contacts to the conductive element, occupies a few cubic inches of space, and operates reliably in severe thermal, shock, and radiation environments. Detailed calculations, drawings, redundancy, and testing procedures for the system elements are described. (7 figures, 1 table) (auth)

28271 FIXED-ANGLE NEUTRON DIFFRACTOMETER. Lee, Yun-peel (Atomic Energy Research Inst., Seoul). J. Korean Phys. Soc., 4: No. 2, 47-50(Sep 1971).

In order to overcome the resolution problem of the two-axis neutron diffractometer installed at the Atomic Energy Research Institute, Seoul, an arrangement for the sample and monochromator contrary to that used in conventional diffractometers was adopted. The intensity and resolution problems of this so-called Fixed Angle Diffractometer are discussed. (4 figures) (auth)

28272 PARASITIC X-RAYS FROM ELECTRONIC DEVICES. Biro, Tamas (Kossuth Lajos Tudomanyegyetem Kiserleti Fizikai Intezete, Debrecen, Hungary). Izotoptechnika; 14: No. 10, 479-87(Oct 1971). (In Hungarian).

Electronic devices in which electrons are accelerated with higher than 5 kV can be sources of parasitic x rays. Special requirements are to be met by the instrument for their control because of the low energy and narrow beams of the radiation. (3 figures, 1 table) (auth)

28273 DEISTVIE PRONIKAYUSHCHEI RADIATSII NA RADIODETALI. (Action of Penetrating Radiation on Radio Components). Goryacheva, G. A.; Shapkin, A. A.; Shirshev, L. G. Moscow; Atomizdat (1971). 120p.

After a general discussion of the interaction of gamma and neutron radiation with materials used in the construction of radio

components, specific components are considered. The effects of ionizing radiation on resistors and the resulting changes in resistance are treated. Also changes produced in the capacitance of condensers and the resistance of insulators are studied. Experimental methods for measuring the above effects in connection with different types of radiation are discussed. (52 references.) (K.S.W.)

28274 SIMPLE SIX-DECADE CURRENT-TO-FREQUENCY CONVERTER. Kisielewski, J.; Zapalski, G. (Inst. of Nuclear Physics, Krakow). Nucl. Instrum. Methods; 99: No. 2, 425-6 (1972).

A current-to-frequency converter for the range 3 nA to 3 mA is described. The circuit was used as an ion current integrator. (2 figures) (auth)

28275 GEOGRAPHIC POSITION LOCATOR. Salisbury, John D.; Gustavson, Marvin R.; Foster, John S. (to United States Atomic Energy Commission). U. S. Patent 3,636,323. 18 Jan 1972. Filed 1 May 1970.

A system is described which includes methods for tracking its own geographic position, comparing that position with stored boundary data, (i.e., a map), and responding whenever the apparatus crosses the boundary as defined on the map. In operation, inertial measurements are processed to produce signals representative of computed position. These signals are compared with stored positional data, whereupon a response mechanism may be activated. The system includes a means for determining its motion state so that the system can calibrate itself when there is no significant motion. Thus, the system offers new options for the use of conventional as well as nuclear weapons, as well as for position determination of other types of vehicles. (4 figures). (auth)

28276 CAPACITANCE METHOD AND APPARATUS FOR DETECTING AN INTERFACE BETWEEN ELECTRICALLY CONDUCTIVE IMMISCIBLE LIQUIDS. Long, Jack L. (to United States Atomic Energy Commission). U. S. Patent 3,644,821. 22 Feb 1972. Filed 14 Jan 1969.

An interface level detector is described comprising a pair of electrodes each positionable in electrical contact with contiguous immiscible liquids wherein at least one of said liquids is electrically conductive, a source of alternating current in electrical series with the electrodes, means for moving one of said electrodes to the interface of said liquids and a voltage indicator electrically connected to said source of alternating current for sensing a change in electrical charge when said moving electrode reaches the interface between the liquids. The level detector may be used in the electro-refining cell for purification of plutonium metal as disclosed in U. S. Pat. No. 3,098,028 and 3,282,806. (auth)

28277 CONTINUOUS DIGITAL RATEMETER. Rudnick, Stanley J.; Michaud, Paul L.; Porges, Karl G. (to United States Atomic Energy Commission). U. S. Patent 3,646,330. 29 Feb 1972. Filed 28 May 1970.

A continuous ratemeter having a digital output is described. The ratemeter has relatively long integration periods while producing a substantially continuous output. The ratemeter develops a delayed replica of the input pulse train and can indicate differential as well as integral count rates. (auth)

28278 PROCEEDINGS OF THE TWENTY-NINTH ANNUAL MEETING OF THE ELECTRON MICROSCOPY SOCIETY OF AMERICA, BOSTON, MASSACHUSETTS, AUGUST 9–13, 1971. Arceneaux, Claude J. (ed.). Baton Rouge, La.; Claitor's Publishing Division (1971). 607p. (CONF-710833).

291 papers are presented under the general topics of the history of the electron microscope, high resolution electron microscopes, scanning microscopy, accessories and techniques, analysis on the electron microscope, radiation effects, image processing, metals, non-metals and minerals, lattice images, diffraction, composites and alloys, microbiology, neuromuscular systems, pathology, protozoa and bacteria, botany, viruses and tumors, biological transport, invertebrate cytology, macromolecular structure, biological techniques, endocrinology, nuclear structure and subcellular organization, cell surfaces, and drug induced effects. (W.H.K.)

28279 ADVANCES IN ELECTRONICS AND ELECTRON PHYSICS. VOLUME 29. Marton, L. (ed.). New York; Academic Press, Inc. (1970). 340p. $18.00.

Separate abstracts were prepared for the five papers presented (W.H.K.)

For abstracts of individual papers see: 28137, 29009, 29065, 29070, and 29868.

28280 PROCEEDINGS OF THE 25th ANNUAL ISA CONFERENCE, PHILADELPHIA, OCTOBER 26–29, 1970. Advances in Instrumentation, Volume 25, Part 1. Pittsburgh; Instrument Society of America (1970). 284p. (CONF-701005-(Pt.1)).

Separate abstracts were prepared for 2 of the 84 papers presented. The remaining 82 papers were not within the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 28742 and 30254.

28281 PROCEEDINGS OF THE 25th ANNUAL ISA CONFERENCE, PHILADELPHIA, OCTOBER 26–29, 1970. Advances in Instrumentation, Volume 25, Part 2. Pittsburgh; Instrument Society of America (1970). 184p. (CONF-701005-(Pt.2)).

Separate abstracts were prepared for 3 of the 68 papers presented. The remaining 65 papers were not within the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 28246, 28262, and 28263.

28282 PROCEEDINGS OF THE 25th ANNUAL ISA CONFERENCE, PHILADELPHIA, OCTOBER 26–29, 1970. Advances in Instrumentation, Volume 25, Part 4. Pittsburgh; Instrumentation Society of America (1970). 178p. (CONF-701005-(Pt.4)).

Separate abstracts were prepared for 2 of the 74 papers presented. The remaining 72 papers were not within the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 28247 and 28687.

28283 XI INTERNATIONAL AUTOMATION AND INSTRUMENTATION CONFERENCE. VOLUME 1. Conference Held at Milan, November 23–25, 1970. Milan; Federazione delle Associazioni Scientifiche e Technische (1970). 866p. (In several languages). (CONF-701145-(Vol.1)).

Topics include general systems and control theory, control and observation problems, stability problems, synthesis problems, discrete systems theory, optimization and mathematical programming, pattern recognition, identification and modeling, components and applications, and instrumentation. Separate abstracts were prepared for 4 of the 51 papers presented. The remaining 47 papers were not within the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 28138, 28228, 30466, and 30467.

28284 XI INTERNATIONAL AUTOMATION AND INSTRUMENTATION CONFERENCE. VOLUME 2. Conference Held at Milan, November 23–25, 1970. Milan; Federazione delle Associazioni Scientifiche e Technische (1970). 740p. (In several languages). (CONF-701145-(Vol.2)).

Topics include data acquisition, process control involving the use of computers, and bio-engineering. Forty papers are presented. (W.H.K.)

28285 USE OF A MICHELSON INTERFEROMETER FOR CONTINUOUS GAS ANALYSIS IN THE FAR INFRA-RED. Chantry, G. W. (National Physical Lab., Teddington, Eng.); Fleming, J. W.; Fuller, D. W. E.; Gebbie, H. A.; Steventon, B. R. Infrared Phys.; 12: No. 1, 35-44(Mar 1972).

The theory of the Michelson interferometer is discussed with particular regard to possible applications in the field of gas analysis. When the moving mirror of the interferometer is offset from the zero path difference position, the spectral transmission becomes a cosinusoidal function of frequency. A gas analyzer to determine the concentration of uranium hexafluoride in the presence of impurities was constructed using this principle. The mirror offset can be chosen so that the instrument responds at the frequency of the UF_6 absorption band, yet remains insensitive to the pure rotation spectral lines of HF, the only impurity to absorb in this particular region. The instrument is versatile and should be of value in other gas analysis problems. (auth)

28286 USE OF A PORTABLE MULTICHANNEL ANALYSER FOR CONTAMINATION STUDIES IN THE FIELD. Amardeil, P.; Delcroix, V.; Jeanne, G.; Logre, P. (CEN, Grenoble, France). pp 487-97 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In French).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

With the usual type of portable radiation protection equipment one can make a rapid assessment of a radiation hazard and estimate the extent of the contamination; one cannot, however, predict how the radiation hazard will develop over time, as this depends on the nature of the radionuclides involved. A major step

towards solving the problem consists in using a multichannel analyzer. However, the analyzers currently being built are for laboratory use and are difficult to transport. An analyzer was developed which is both simpler than the usual type and portable. The device in question is described, and it is shown how it is used in the rapid identification of contaminants and, hence, in obtaining a fairly accurate idea of the hazard and the way in which it is likely to develop over time. (13 figures) (auth)

28287 PORTABLE MULTICHANNEL ANALYSER FOR FIELD MEASUREMENTS OF ENVIRONMENTAL RADIOACTIVITY. Ebeling, G.; Seyfried, P. (Physikalisch-Technische Bundesanstalt, Brunswick). pp 539-48 of Rapid Methods for Measuring Radioactivity in the Environment. Vienna; International Atomic Energy Agency (1971). (In German).

From International symposium on rapid methods for measuring radioactivity in the environment; Neuherberg, Ger. (5 Jul 1971). See STI/PUB-289; CONF-710705.

The analyzer described was designed for the special requirements of simple and fast measurements of environmental radioactivity. Because of its small dimensions (27 cm × 11 cm × 29 cm) and a weight of only 5 kg it may be carried by a single person even in the field. The Hutchinson–Scarrott principle was used, with a recirculating memory made of 2 MOS shift registers, each of 1024 bits. The memory is divided into 128 channels with a capacity of 2^{16}. A circulating frequency of 500 Hz was chosen. The memory content is displayed on a CRT in a linear scale from 2^6 to 2^{16} counts full scale. A selected channel is intensified. Selection is made by means of a 10-turn potentiometer. The corresponding channel number may be read from the dial. The content of the selected and intensified channel may be read from a moving coil meter. In addition, the voltage at the meter is used for the y shift of an x–y recorder, while the potentiometer controls the x shift. The total power consumption of 2.5 W is reduced to 1.5 W by switching off the CRT display. Eight batteries (IEC R 20 or equivalent accumulators) power the instrument for a continuous operation of at least ten hours. In conjunction with a special scintillation detector including a low-power, high-voltage generator (46 mW), a complete spectrometer for field use is obtained. (7 figures) (auth)

28288 SIMPLE METHOD FOR COMPLETE PROCESSING OF DATA FROM LIQUID SCINTILLATION COUNTERS. Barber, H. E.; Bourne, G. R.; Buckley, G. A. (Univ. of Liverpool). J. Physiol. (London); 219: No. 2, 4P-5P(Dec 1971).

The advantages of data processing of liquid scintillation data, by means of a central computer, are discussed with reference to the Liverpool University KDF 9. The system is based on a small liquid scintillation spectrometer with a ^{133}Ba external standard and lister that was used, among other experiments, for the measurement of cholinesterase activity in cells or motor end-plates, renal clearance of insulin in the rat, and compartmental analysis of drug distribution and excretion. (UK)

28289 DATA PROCESSING IN ^{14}C-MEASUREMENTS. I. RECORDING AND STATISTICAL CHECK. Erlenkeuser, H.; Willkomm, H. (Univ., Kiel). Atomkernenergie; 19: No. 2, 123-6 (Apr 1972).

In order to check the longtime measurements of ^{14}C-dating equipment the relevant counting registers are tape punched periodically. The organization and the control of the data processing are discussed. A computer program is described that checks the data for disturbances. Statistically consistent data are summed up for further evaluation. (auth)

28290 CALIBRATION OF ELECTROCHEMICAL OXYGEN METERS IN SODIUM USING URANIUM. Isaacs, Hugh S. (Brookhaven National Lab., Upton, N. Y.). J. Electrochem. Soc.; 119: No. 4, 455-9(Apr 1972).

Methods using uranium to remove or getter oxygen quantitatively from sodium have been used to calibrate the potential of the meter as a function of the oxygen concentration in sodium. The oxygen meters were constructed with sodium-sodium oxide reference electrodes and ThO_2–Y_2O_3 electrolytes. The calibration methods depended on the deviation of these meters from ideal behavior. The methods involved the summation of the weight gains of uranium, i.e., the weights of oxygen removed from the sodium, the derivative of the weight gains for a given potential change as a function of the number of repetitive oxygen removal steps, and the time dependence of the potential during the removal of oxygen from sodium by lithium. The behavior of a meter depended on the purity of the ThO_2–Y_2O_3 electrolyte used. High-purity electrolytes gave the theoretical dependence of potential on concentration but impure tubes showed marked deviations from theoretical behavior at low concentrations at temperatures of 500°C. (auth)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

Isotope Separation (Industrial)

28291 (JUL-808-PC) AUTOMATIC EQUIPMENT FOR FILLING COLD TRAPS OF A MASS SEPARATOR WITH LIQUID NITROGEN. Kurz, U.; Lipperts, H.; Petrick, W. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Physikalische Chemie). Nov 1971. 25p. (In German). Dep. NTIS (U. S. Sales Only).

Automatic equipment for simultaneously supplying multiple cold traps in a high-vacuum installation with liquid nitrogen from a pressure tank is described. This apparatus permits the supplying of liquid nitrogen to cold traps of the Sidonie-type mass separator at the Institute for Physical Chemistry of the KFA-Juelich. Specific details of the mechanical construction and the electrical circuit used are presented. (tr-auth)

28292 (ORO-685) DATA ON NEW GASEOUS DIFFUSION PLANTS. (Oak Ridge Operations Office (AEC), Tenn.). Apr 1972. 68p. Dep. TIC.

Preliminary estimates of the costs of new gaseous diffusion plants capable of product assays in the range of 3 to 4% ^{235}U and located in the U. S. at sites comparable to those of existing U. S. plants are presented. Data are shown for plants of 8.75 million-SWU/yr (separative work units/yr) and 17.5 million-SWU/yr capacity based on 1970 Technology, and for a plant of 8.75 million-SWU/yr capacity based on Projected Advanced Technology. The precise sizes of plants chosen for study have no special significance; however, a plant size of 17.5 million SWU/yr would about equal the combined capacities of existing U. S. plants and is not unreasonably large in relation to projected future demands, and a smaller plant (conveniently one-half of this size or 8.75 million SWU/yr) seems of logical interest from the standpoint of dispersed siting or ownership. Plant designs for capacities below 8.75 million SWU/yr have not been of primary interest because large size plants are indicated to be required by the projected demands on the U. S. uranium enrichment industry. Data for 1970 Technology reflect the use of technology which is now essentially in hand and which represents a substantial improvement over presently installed technology. Data for the Projected Advanced Technology reflect the use of reasonable projections of known technology which could be available for plant installation in the late 1970's as the result of further development effort. The Projected Advanced Technology is based on anticipated improvements in component and process efficiencies along with reductions in the cost of some components. For example, significant increases in the efficiency of both barriers and compressors are projected, together with power recovery schemes which would markedly improve overall power utilization efficiency. Also, the redesign of the diffusion stage configuration by a combination of new compressor, diffuser and piping arrangements will improve flow efficiency within the stage and will result in a more compact and less expensive installation. The Projected Advanced Technology, however, does not represent the limit of efficiency of the gaseous diffusion process; still more advanced concepts of technology, stage arrangements, and drive systems which have a potential for further substantial reductions in the cost of separative work are believed to be feasible. Stage equipment sizes for both the 1970 and Projected Advanced Technologies for a plant of 8.75 million SWU/yr are comparable to the stage equipment sizes of existing plants, but they would be larger for a plant of 17.5 million SWU/yr. (auth)

28293 COUNTERCURRENT ION-EXCHANGE SEPARATION OF MIXTURES WITHOUT THE USE OF AUXILIARY IONS. Gorshkov, V. I.; Kurbanov, A. M.; Apolonnik, N. V. (Moscow State Univ.). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 11, 1686-7(Nov 1971).

Translated from Zh. Fiz. Khim.; 45: No. 11, 2969-70(Nov 1971).

When a countercurrent flow of phases is employed, there is a possibility of separation without the use of auxiliary ions. To achieve this, with the resin saturated by the ions to be separated circulating continuously through the column, the enriched mixture is displaced by the mixture with the initial composition under conditions where the resin selectivity in relation to the ions undergoing separation differs from its selectivity in the separating section of the column. The changes in selectivity are achieved by varying process conditions, such as the concentration of the solution, its pH, temperature, solvent composition, and by introducing complex-forming reagents. (auth)

Isotopic Power Sources

Refer also to abstract 28543.

28294 (DP-1293) SAVANNAH RIVER LABORATORY ^{60}Co POWER AND HEAT SOURCES. Quarterly Progress Report, October-December 1971. Angerman, C. L. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Feb 1972. Contract AT(07-2)-1. 26p. Dep. NTIS.

The rapid, break-away oxidation observed in Haynes 25 and Haynes 188 after extended times at 1000°C, and above, is preceded by localized attack and accompanied by rapid intergranular attack and formation of $CoWO_4$ in the oxide scale. Satisfactory performance was demonstrated through 20,000 hr at 900 to 1000°C with fifteen active capsules of Hastelloy X, Hastelloy C, Haynes 25, and Inconel 600. Widths of compatibility-reaction and oxidation-affected zones in active capsules were the same as those in inactive capsules. The Hastelloy X being used for fuel capsules and fuel pins for the WANL heat source exhibited satisfactory oxidation resistance during 3000-hr tests at 1000 and 1125°C. A thermoelectric generator fueled with ^{60}Co continued to operate satisfactorily after 10 months with an electrical output of 64 watts. (auth)

28295 (FRNC-CONF-13) THERMOELECTRIC CONVERSION PROCESS: APPLICATION TO RADIOISOTOPE SOURCES. Alais; Stahl (CIT-Alcatel, Bruyers-le-Chatel (France). Centre Pierre Herreng). 20 Apr 1971. 20p. (In French). (CONF-710444-6). Dep. NTIS (U. S. Sales Only).

From International conference on chemical sciences; Paris, France (20 Apr 1971).

The efficiency of a thermoelectric generator depends on two factors; the conversion yield of the thermoelectric material and the thermal losses due to imperfections in the insulator. The various semiconducting elements used in these generators are classified according to their working temperature; for a given type of material the thermal losses include a term which is independent of the thickness of the insulator. Examples are presented of the GISETTE V, a 15w underwater generator, possessing a 70,000 Ci strontium titanate hot source (400 W(t)) and GIPSIE, a generator used with pacemakers (total weight, 40g, 200μW power, containing 150 mg of ^{238}Pu). The radioisotopes commonly used in thermoelectric generators are listed. (France)

28296 (HIT-4086-3) HEART HEAT SOURCE FUEL CAPSULE PARAMETRIC STUDY. [Final Report]. (Hittman Associates, Inc., Columbia, Md.). Feb 1971. Contract AT(30-1)-4086. 95p. Dep. NTIS.

A fuel capsule parametric study was performed to evaluate the important parameters which affect the design of an optimized radioisotope fuel capsule for use with an implantable heart device. Both vented and non-vented concepts were considered. The relative performance of a number of candidate capsule materials was also obtained. Typical capsule designs are presented with a series of venting concepts to illustrate realistic fabrication techniques. Study conclusions are that non-vented capsules weigh 0.95 lbs, capsules with selective vents weigh 0.75 lbs, and those with non-selective vents weigh 0.32 lbs for 30 W sources in optimum configurations. Volumes are 50, 29, and 12 cm^3, respectively. The right cylindrical shape is recommended as most attractive. There is negligible weight difference between this and the spherical shape. The recommended concept uses both selective and non-selective vents, thereby obtaining the weight and volume advantages of the non-selective vent behavior with the advantages of no release of radioactive gas which is the advantage of the selective vent. The non-selective vent is normally inactive, and is isolated by a burst disk. (auth)

28297 (MLM-1890) STACKING SPHERES IN A CYLINDER WITH APPLICATION FOR THE MULTI-HUNDRED-WATT HEAT SOURCE. Madachy, J. S. (Mound Lab., Miamisburg, Ohio). 15 Mar 1972. Contract AT-33-1-GEN-53. 10p. Dep. NTIS.

The multi-hundred-watt heat source is to be a closed cylinder containing 24 radioactive spheres. Formulas giving the dimensions of a cylinder which will hold equal-diameter tangent spheres arranged peripherally around the inside of the cylinder and in close-packed tangent layers are derived. Modifications in the formulas for three and four spheres per layer are also given to allow spacing between the spheres in a layer and between layers. Calculations of the ratio of cylinder volume to total sphere volume show that there are minimum ratios for one sphere per layer and for four spheres per layer. Calculations are also included showing

that six spheres per layer produce the minimum-weight cylinder. (auth)

28298 MODEL OF A RADIONUCLIDE POWER SOURCE FOR DEMONSTRATION PURPOSES. Conrad, H. (Technische Univ., Munich). Kerntechnik; 14: No. 2, 61-4(Feb 1972). (In German and English).

A thermoelectric battery was built, using ^{90}Sr as the heat source. The ^{90}Sr, in the form of $^{90}SrTiO_3$ pellets encapsulated in a cylinder of V2A steel, had an initial activity of 156 Ci. The battery has 850 iron/constantan thermocouples. At the initial temperature difference of 80°K between the hot and the cold junctions, the battery supplied an open circuit voltage of 1.9 V and a maximum power output of 0.24 mW, corresponding to an efficiency factor of 0.023%. This battery was used to power two demonstration experiments: a device for igniting vacuum flash lamps and a small electronic organ. (auth)

Radiation Sources

Refer also to abstracts 28029, 28031, 28095, and 28246.

28299 (BNL-50316) DOSE DISTRIBUTION, DOSE UNIFORMITY, AND MINIMUM DOSE DATA FOR SQUARE ^{134}Cs SOURCE PLAQUES. Galanter, L. (Brookhaven National Lab., Upton, N. Y.). Nov 1971. Contract AT(30-1)-16. 101p. Dep. NTIS.

Data for cesium-134 rectangular slab sources are presented. The tabulated data makes available to the designer of package irradiators the dose distribution information necessary to perform quick, easy, and reasonably accurate calculations of the dose distribution characteristics of irradiators when using cesium-137 sources which may contain cesium-134 impurities. (auth)

28300 (BNL-50317) TABULATED DOSE UNIFORMITY RATIO AND MINIMUM DOSE DATA: RECTANGULAR ^{60}Co SOURCE PLAQUES. Galanter, L. (Brookhaven National Lab., Upton, N. Y.). Dec 1971. Contract AT(30-1)-16. 148p. Dep. NTIS.

Data are tabulated which extend to rectangular cobalt-60 plaques the information presented for square plaques in BNL 50145 (Revised). The user is referred to BNL 50145 (Revised) and to other listed reports for a complete discussion of the parameters involved in data generation and for instructions on the use of these data in gamma irradiator design. (auth)

28301 (BNL-50318) TABULATED DOSE DISTRIBUTION DATA: RECTANGULAR ^{60}Co SOURCE PLAQUES. Galanter, L. (Brookhaven National Lab., Upton, N. Y.). Dec 1971. Contract AT(30-1)-16. 76p. Dep. NTIS.

Data are tabulated which extend to rectangular cobalt-60 plaques the information presented for square plaques in BNL 50147 (Revised). The user is referred to BNL 50147 (Revised) and to the other listed reports for a complete discussion of the parameters involved in data generation and for instructions on the use of these data in gamma irradiator design. (auth)

28302 (BNL-50319) TABULATED DOSE UNIFORMITY RATIO AND MINIMUM DOSE DATA: RECTANGULAR ^{137}Cs SOURCE PLAQUES. Galanter, L. (Brookhaven National Lab., Upton, N. Y.). Dec 1971. Contract AT(30-1)-16. 148p. Dep. NTIS.

Data are tabulated which extend to rectangular cesium-137 plaques the information presented for square plaques in BNL 50145 (Revised). The user is referred to BNL 50145 (Revised) and to the other listed reports for a complete discussion of the parameters involved in data generation and for instructions on the use of these data in gamma irradiator design. (auth)

28303 (BNL-50320) TABULATED DOSE DISTRIBUTION DATA: RECTANGULAR ^{137}Cs SOURCE PLAQUES. Galanter, L. (Brookhaven National Lab., Upton, N. Y.). Dec 1971. Contract AT(30-1)-16. 76p. Dep. NTIS.

Data are tabulated which extend to rectangular cesium-137 plaques the information presented for square plaques in BNL 50147 (Revised). The user is referred to BNL 50147 (Revised) and to other listed reports for a complete discussion of the parameters involved in data generation and for instructions on the use of these data in gamma irradiator design. (auth)

28304 RESEARCH IN RADIOISOTOPE TECHNOLOGY. Gregory, J. N. (Australian Atomic Energy Commission, Lucas Heights). At. Energy Aust.; 15: No. 1, 20-30(Jan 1972).

Research in applications of radioisotopes and radiation in Australia is reviewed under the following headings: on-stream analysis in the mineral industry; borehole analysis techniques; photographic intensification; radioisotope techniques in hydrology; gas flow measurements; tracing and location of termite galleries and nests; silt and sand tracing; gamma radiation technology; food irradiation; cardiac pacemakers; radiopharmaceutical development; radiation source research; and engineering and process development. Statistics for radioisotope production are tabulated. (Australia)

28305 USE OF RADIONUCLIDES IN BUILDING MATERIAL INDUSTRY. Kominek, A. (Vyzkumny Ustav Stavebnich Hmot, Brno). Radioisotopy; 13: No. 2, 415-21(1972). (In Czech).

A survey is given of the utilization of radionuclides in the building material industry. The radioisotope applications in this area involve material level gaging, piece counting, physical parameters or chemical constitution determination, material transport control, material structure control, investigation of the mechanism and kinetics of silicate reactions, and the use of sealed radioactive sources in radiation induced polymerization. (auth)

28306 SMALL HIGH-FLUX BETA-PARTICLE IRRADIATOR. Taylor, R. G. S. (Queensland Radium Inst., Herston, Australia). Australas. Bull. Med. Phys. Biophys.; No. 52, 20-3(Mar 1972).

A clinical requirement for a small, high-flux beta-particle source was met by using a 6 mm × 4 mm area of very thin (0.025 mm) beta-emitting gold foil, prepared by rolling gold capillary tubing from which 70 mCi of radon had been extracted after it had come into radioactive equilibrium with its active deposit. The foil was mounted on a suitable holder and calibrated against a strontium-90 applicator of known surface dose rate, using an instrument incorporating a plastic phosphor and a photomultiplier, the anode current being measured with an electrometer. A continuing decay curve plotted from readings of foil activity taken every 10 minutes enabled a correction to the treatment time to be made. The actual beta-particle output at time of use was 10 rads per second. (auth) (Australia)

Design and Fabrication

Refer also to abstract 27971.

28307 ^{252}Cf NEUTRON SOURCE AND METHOD OF MAKING SAME. Baybarz, Russell D.; Peterson, Joseph R. (to United States Atomic Energy Commission). U. S. Patent 3,640,888. 8 Feb 1972. Filed 11 Dec 1969.

A radiation source has been provided which is free of radioactive surface contamination comprising a solid quartz bead containing a spontaneously fissionable element distributed substantially evenly within the confines of an outer glass shell. A method has been provided for preparing the source comprising sorbing a spontaneously fissionable element on quartz powder in a quartz capillary and subsequently fusing the powder and capillary to contain the neutron-emitting material. (Official Gazette)

Industrial Uses

Refer also to abstracts 28348, 28350, 28361, 28380, 28382, 28383, 28387, 28394, 28421, and 28496.

28308 (PAEC(D)AG-642) PRELIMINARY REPORT ON THE RIPENING OF GAMMA IRRADIATED MANGO. Herrera, J. R.; Valencia, I. G. (Philippine Atomic Research Center, Manila). Jul 1964. 7p. Dep. NTIS (U. S. Sales Only).

Newly harvested fully matured green fruits of the carabao variety of mango were individually packaged in polyethylene (200 gage) bags provided with eight respiration vents. The packaged fruits were divided at random into four lots of fifteen fruits each. The object of the study was to determine the effect of γ radiation on the ripening characteristics of Philippine mango variety Carabao. The lots received the following ^{60}Co γ doses: 0 rad (control); 8,380 rad; 12,450 rad; and 16,600 rad about 24 hr after picking. Analyses for ascorbic acid and β-carotene content were made periodically. From the results obtained it seemed that for the γ doses used in this preliminary study, the Philippine mango had lower radiosensitivity as compared to data reported on Indian mangoes. Initially, ascorbic acid content of the irradiated green fruits was greatly reduced, however, as the fruit ripened no significant difference was observed. The carotene content initially seemed to be unaffected but as the fruit ripened it increased. Shelf life of the fruit was not affected by the γ doses used. (C.H.)

28309 EFFECT OF GAMMA RADIATION ON FREEZE-DRYING RATES. Hatcher, John D.; Sunderland, J. Edward (North Carolina State Univ., Raleigh). J. Food Sci.; 37: No. 2, 336 (Mar-Apr 1972).

A study was conducted to determine the influence of gamma radiation on freeze-drying rates of 1-in. thick beefsteaks. Radiation levels of the magnitude used in this investigation offer no real benefits for freeze drying unless very thick samples are used. Although no irradiation off-odors were detected, this phase may warrant further study. (auth)

28310 REPORT ON THE RESEARCH RESULT OF SPROUT INHIBITION OF POTATOES BY IRRADIATION. Genshiryoku Iinkai Geppo; 16: No. 7, 31-6(Jul 1971). (In Japanese).

A study on the sprout inhibition of potatoes by irradiation was carried out. When potatoes were irradiated with the doses of from 7000 to 15,000 rad ^{60}Co γ rays, potato sprouting could be inhibited for 8 months after harvest and storage at room temperature with no change in taste, smell, and food quality. Further investigations were carried out to study the existence of the health hazards due to the irradiated potatoes. No induced radioactivity was observed. No changes in the nutritive elements between the irradiated potatoes and the non-irradiated potatoes were observed. No problems were offered from the view of sanitary chemistry. Results from short-term and chronic effects tests of the poisonous character and next generation tests in monkeys, mice, and rats, indicated that there were no health hazards from the irradiated potatoes below a dose of 15 krad. It was concluded that sprout inhibition of potatoes by irradiation below 15 krad was practicable. (Japan)

28311 PROSPECTS FOR RADIATION TECHNIQUES IN DYEING AND FINISHING. Byrne, G. A.; Jones, D. M. (Shirley Inst., Didsbury, Eng.). J. Soc. Dyers Colour.; 87: No. 12, 496-502(Dec 1971).

The role, actual and potential, of high-energy and low-energy radiation in textile technology is evaluated. Emphasis is placed on the ^{60}Co source and the electron accelerator as high-energy sources, and the glow discharge as a source of low-energy radiation. The effect of high-energy radiation on the structure and properties of fibers is reviewed. Two types of effect may be produced: crosslinking and degradation. The latter predominates with some polymers, whereas with others crosslinking of the polymer chains is the major effect. It is concluded that the direct effects of high-energy radiation are of insufficient value to justify its application to textiles without some simultaneous or subsequent chemical treatment of the fiber. The free radicals produced by the radiation serve as reactive sites at which the graft copolymerization of monomers may be initiated within the fiber structure. Three methods are available for the radiation grafting of unsaturated monomers on to fibrous substrates: the simultaneous method, the post-irradiation method, and the peroxide method. Most effort in this area has been devoted to the modification of synthetic-polymer fibers to make them more readily dyeable. Several examples of this are described. To achieve good penetration of the graft copolymer into the fiber, it is necessary that the fiber should be sufficiently swollen to permit penetration by the monomer molecules. Experiments on the swelling of polyester fibers in relation to grafting are described. The use of radiation-initiated grafting in the finishing of textiles is discussed. The outstanding example of this, one that has achieved commercial exploitation, is the Deering Milliken Visa process for conferring durable-press properties on cotton and cotton-polyester fabrics. Flame-resistant cotton can also be produced by radiation-grafting techniques. The modification of the surfaces of textile fibers, for example, to confer soil-release and antistatic properties, is another potential application of radiation grafting in textile finishing. The deposition of coatings on solid surfaces by low-energy gas-discharge techniques has been the subject of many investigations. Recent work has shown that several percent of vinyl monomers can be deposited on polyester fabric by means of the glow discharge. With hydrophilic monomers, the fabrics have improved antisoil and soil-release properties. Terylene (ICI) fabrics treated in a glow discharge with acrylic acid can be dyed to solid colors with basic dyes. A brief assessment of the economics of radiation processes in relation to their use in textile technology is included. (auth)

28312 CONTRACT STERILIZATION BY RADIOISOTOPE IRRADIATION. Dietz, George R. (Radiation International, Parsippany, N. J.). Bull. Parenter. Drug Ass.; 25: No. 5, 252-6(Sep-Oct 1971).

The concept and advantages of radiation sterilization using ^{60}Co are described. Some of the many uses of nuclear radiation and typical radiation sources and facilities are discussed. The physical facilities used for sterilization are described. General cost data is included for both contract sterilization and radiation sterilization if accomplished by a company with its own unit. (auth)

28313 POTATO IRRADIATION RESEARCH REPORT. At. Jap.; 15: No. 9, 9-13(Sep 1971).

Potatoes irradiated with dosages of 7000 or 15,000 rads did not germinate. If irradiated in dosages ranging from 7000 rad to 15,000 rad during the period of 6 months after harvesting, the potatoes can be stored at normal room temperature for 8 months, and excel non-irradiated potatoes in taste, fragrance, and processibility. The application of gamma rays from ^{60}Co did not cause any radioactive induction in the constituent elements of the potatoes. Irradiation caused virtually no change in vitamin B_1, B_2 and starch contents. In the long-term chronic toxicity test and subsequent generation test using mice, as well as the short-term toxicity test using monkeys, the effects of irradiation including both teratogenic and carcinogenic effects were not observed. The dose of 15,000 rad was considered to be a threshold of effect-free level of toxicity of irradiated potatoes using various animals. It is claimed that: proper dosages of irradiation prevents potatoes from both germinating and decomposing; there is no possibility that a life-time intake of irradiated potatoes will cause cancer or a malformed child; and irradiation increases the amount of sugar and thus improves the taste with little change in nutritive value. (Japan)

LIFE SCIENCES

28314 (CONF-710834-(Absts.)) ELEVENTH CONFERENCE ON PHYSICS IN MEDICINE AND BIOLOGY, MELBOURNE, 19th-21st AUGUST, 1971. Notes to Delegates and Abstracts. (Australian Inst. of Physics, Parkville). 10p.

Abstracts of 16 papers are presented. Topics include technical considerations in the calibration of low energy x-ray generators; variability in the beam from an A.E.I. series III linear accelerator; a small high-flux beta-particle irradiator; computer program for generalized radiotherapy planning; geographical distribution of erythema induced by uv in relation to skin cancer; tolerance of scale insects to life-long irradiation by beta particles from ingested ^{14}C; magnetic recording of gamma camera images; absorbed dose considerations in the use of radiopharmaceuticals in nuclear medicine; ^{90}Y seeds in the treatment of pituitary disorders; reproducibility of computer processed cerebral blood flow studies; developments in semiconductor nuclear radiation detectors; laser monitoring and hazard evaluation; monitoring of leakage from microwave ovens; and discharge authorizations for nuclear power stations. (Australia)

28315 ADVANCES IN CANCER RESEARCH. VOLUME 14. Klein, George; Weinhouse, Sidney (eds.). New York; Academic Press, Inc. (1971). 428p. $22.50.

Eight chapters report recent findings in cancer research. A separate abstract was prepared on one chapter that reports results of epidemiological surveys on cancer incidence in irradiated human populations. (C.H.)

For an abstract of an individual chapter see: 28411.

28316 SKIN. Helwig, Elson B.; Mostofi, F. K. (ed.). International Academy of Pathology, Monographs in Pathology, No. 10. Baltimore; Williams and Wilkins Company (1971). 630p. $33.00.

Thirty chapters cover the physiology and pathology of the human skin. A separate abstract was prepared for one chapter that described pathological changes induced by ionizing radiations. (C.H.)

For an abstract of an individual chapter see: 28412.

Radiation Effects on Biochemicals (External Source)

Refer also to abstracts 27899 and 28400.

28317 EXPERIMENTAL INVESTIGATIONS ON THE RADIATION-PROTECTIVE ACTION OF HISTAMINE. Sturde, Hans-Carl; Gorschlueter, Klaus; Heitmann, Hans-Joachim (Bundeswehrzentralkrankenhaus, Koblenz, Ger. Ruhr-Univ., Bochum, Ger.). Strahlentherapie; 142: No. 5, 601-4(Nov 1971). (In German).

Data are reported on the radiation-protective action of histamine. By means of a very sensitive biological experimental arrangement, a radiation-protective effect by a mixture of histamine in different concentrations to the indicator (a watery solution of bradykinin) was demonstrated. Under uniform administration of 8000 R, the x irradiation conditions remaining constant, an addition of 6 μg of histamine per milliliter of bradykinin solution did not show any effect, whereas loss of activity of the bradykinin solution, induced by radiation (measured on the isolated surviving terminal ileum of guinea pigs) was prevented by addition of histamine (12, 24, 48 μg) in correlation to its concentration. By addition of 96 μg of histamine per milliliter bradykinin solution, finally, a complete radiation protection was attained. (auth)

28318 EFFECT OF γ RAYS ON URACIL AND URIDYLIC ACID IN AERATED AQUEOUS SOLUTION. Ducolomb, Reine; Cadet, Jean; Teoule, Robert (CEA, Grenoble, France). Compt. Rend., Ser. D; 273: No. 25, 2647-9(20 Dec 1971). (In French).

Gamma irradiation of 10^{-3}M uracil in an aerated solution with a pH of 6 led to the identification of the following radiolysis substances: (I) cis and (II) trans 5,6-dihydroxy 5,6-dihydro uracil, (III) N-formyl N'-glyoxalylurea, (IV) dialuric acid, (V) alloxan, (VI) 5-hydroxy-hydantoin, (VII) parabanic acid, (VIII) oxalylurea, (IX) formylurea, and (X) urea. The determination of these different compounds in terms of the radiation dose received enabled a complete experimental scheme to be established for the chain of products produced in the radiolysis of uracil. The (I), (II), (III), (IV), (V), (VI), and (VII) products and uracil were observed after the γ radiolysis of 10^{-4}M uridylic acid solutions with a pH of 6. They result from the breaking down of the N-glycoside bonding. The G values for the formation of these substances were calculated. (France)

28319 STUDY OF RADICAL REACTIONS DURING RADIOPROTECTION BY GLYCEROL. Singh, B. B. (Bhabha Atomic Research Centre, Trombay, India). pp 11-20 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Bovine serum albumin, trypsin, gelatin, and DNA were prepared by freeze drying aqueous solutions; glycerol was added to some samples. All samples were given 5 Mrad doses of gamma radiation at 77°K and ESR spectra were recorded at 77°K and room temperature at various intervals of time. Figures are presented to show ESR spectra of all samples. It was found that glycerol had no effect on the ESR spectra of samples irradiated and observed at 77°K. At room temperature, however, glycerol produced a slight increase in the decay of free radicals. In bovine serum albumin samples, glycerol reduced the final concentration of $-CH_2S'$ radicals at room temperature. It was concluded that there are three different ways in which glycerol offers radioprotection: it can scavenge hydroxyl radicals thereby reducing the indirect effects of radiation; it can prevent migration of damage to a vital site by replacing bound water; and it can repair the damage by donating hydrogen. (H.L.W.)

28320 PHOTOBLEACHING OF POST-IRRADIATION THERMOLUMINESCENCE OF NUCLEIC ACID BASES: AN ANALYTICAL APPROACH. Bhattacharjee, S. K.; Desai, T. S.; Tatake, V. G. (Bhabha Atomic Research Centre, Trombay, India). pp 37-44 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Low temperature γ irradiation of biomolecules has been known to cause the formation of free radicals and thermoluminescence (TI) centres. Storage in dark and exposure to white light cause fading and photobleaching of the TI centres even at 77°K. An analytical model describing the possible mechanism of photobleaching action is proposed. This model appears to fit the existing experimental data. Further, it elucidates the possible interaction between the products of radiation action and the visible light on a semiquantitative basis. (auth)

28321 RADIATION INDUCED ALTERATIONS IN MYOGLOBIN FROM FISH SPECIES. Madhavan, V. N.; Kumta, U. S. (Bhabha Atomic Research Centre, Trombay, India). pp 57-69 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Myoglobin offers two major sites for radiation damage, the protoporphyrin nucleus and the apoglobin moiety. In flesh foods, myoglobin forms the major chromoprotein which functions as a catalyst in lipid peroxidation. Myoglobins from two medium fatty fish varieties, Indian salmon and black pomfret, had similar molecular weights and spectral characteristics but varied in their electrophoretic mobilities. On irradiation (0.05 – 0.25 Mrad) they showed an additional band on acrylamide gel and loss of peak heights on DEAE cellulose indicating cleavage. Aggregation was noticed at higher doses with a shift in the elution characteristics on Sephadex G-100 and increasing opalescence of the irradiated myoglobin solutions. Spectral studies revealed conversion of myoglobin to metmyoglobin and its transformation to oxymyoglobin-like substances. Although the pattern of degradation (scission, aggregation and colour changes) was the same, the extent of radiolability of black pomfret myoglobin was more than that of Indian salmon myoglobin, pointing to microheterogeneity in the two myoglobin species. (auth)

28322 INACTIVATION OF FIBRINOGEN CAUSED BY GAMMA-IRRADIATION. Kamat, Hemalata N.; Nadkarni, G. B. (Bhabha Atomic Research Centre, Trombay, India). pp 71-84 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

One of the derangements observed in animals exposed to ionizing radiations is the loss of coagulability of blood, thus causing haemorrhagic disorders. The polymerization of fibrinogen to fibrin by action of thrombin is recognized as the key mechanism in blood clotting. Gamma-irradiation (0-500 kr) of fibrinogen purified from human and bovine sources, brought about significant changes in clottability and clotting time. The dose response studies indicated initial aggregation and subsequent disintegration of the protein. The aggregates formed after irradiation have been compared with normal clot formed by action of thrombin in respect of their physico-chemical properties. The results suggested initial unfolding of fibrinogen through cleavage of disulphide linkages. The clotting properties could be recovered partially through disulphide interchange reaction. At higher doses cysteine and methionine residues were oxidized to cysteic acid and methionine-sulphone respectively. The increased arginine levels in the aggregates indicated failure of release of fibrinopeptides formed during normal clotting. Fibrinogen retained clottability when irradiated in presence of iodoacetic acid and iodoacetamide. (auth)

28323 EFFECT OF ^{60}Co GAMMA RAYS ON ANTIGEN-ANTIBODY INTERACTIONS. Nene, Vidya S.; Phondke, G. P.; Sundaram, K. (Bhabha Atomic Research Centre, Trombay, India). pp 85-101 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Increasing use of radiation sterilization of medical products necessitates studies of possible radiation effects on the physico-chemical and biological properties of such substances. The interaction of normal and irradiated rabbit anti-BSA sera with unirradiated BSA has, therefore, been investigated. Ouchterlony gel diffusion and immunoelectrophoretic studies show a progressive reduction in the intensity of precipitin lines. The antigen binding capacity (ABC33) and precipitating ability (P80) were measured by the Farr technique using ^{131}I-labelled BSA. These show that the avidity of the bond in the antigen-antibody interaction is weakened by irradiation. The effect on the affinity of the interacting site, however, appears to vary with the nature of the antibody immunoglobulin. (auth)

28324 COMPLEMENTARY STRANDS FROM UV IRRADIATED SINGLE STRANDED DNA. Poddar, R. K. (Saha Inst. of Nuclear Physics, Calcutta). pp 103-15 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

The circular, single stranded DNA of bacteriophage 0X174 bearing uv irradiation damage was used as templates for E. coli DNA polymerase under conditions allowing synthesis of not more than one complementary strand per template molecule. The mean length of newly synthesized strands was found to decrease with the number of biologically lethal hits sustained by the irradiated templates; but it was greater than what would be expected if all the lethal hits were to block polymerization process. Lesions that block polymerization absolutely are inferred to be pyrimidine dimers, because it is possible to obtain synthesis of full length complementary strands if heat-denatured uv irradiated, but photoreactivated, double stranded 0X RF DNA is used as a template. Relevance of these results towards observed partial repair in vivo of uv damage of mature 0X174 is discussed. (auth)

28325 BASIS OF INACTIVATION OF TRANSFORMING DNA BY GAMMA-RAYS. Joshi, V. R.; Notani, N. K. (Bhabha Atomic Research Centre, Trombay, India). pp 117-26 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

The fate of ^{32}P-labelled, gamma-irradiated transforming DNA was followed in Hemophilus influenzae. Exposures to gamma-rays that produced up to 90% inactivation of the marker for streptomycin resistance (Sr), did not have significant effect on the normal uptake of this DNA by competent cells. Although, the incorporation of the irradiated donor DNA label into the recipient genome was similar to that of unirradiated DNA label, the specific donor biological activity associated with recipient DNA was very much lower with irradiated DNA. These data can be explained by assuming that gamma-irradiated DNA is subjected to degradation in addition to that observed in normal transformation and the products of degradation are then resynthesized into recipient DNA. Extra degradation could be initiated by the presence of single and double-strand breaks in irradiated DNA. A significant number of such breaks were present in gamma-irradiated DNA. (auth)

28326 PROFLAVINE-DNA INTERACTION SUBSEQUENT TO ULTRAVIOLET IRRADIATION. Dasgupta, Santanu; Chaudhuri, U. C. (Saha Inst. of Nuclear Physics, Calcutta). pp 127-39 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Bacteriophase 0X-174 was pre-irradiated with ultraviolet light (uv) to different survival ratios and then photosensitized in presence of 4 ug/ml proflavine. It was found that under such conditions, the photodynamic inactivation rate was slower than that of the control. This suggested that the change in the conformation of DNA, effected by the pre-irradiation with uv, might inhibit the binding of the dye to DNA with subsequent decrease in the rate of photoinactivation. Among the uv-induced effects on nucleic acids, the formation of pyrimidine dimers was taken up for an in vitro study of the consequence of dimerization on the binding of proflavine to DNA. The effect of dimerformation on the bimodal dye-DNA interaction has been discussed on the basis of spectrophotometric binding curves and binding isotherms. (auth)

28327 STUDIES ON RADIATION SENSITIVITY OF FAT SOLUBLE COMPOUNDS AND DOSE MODIFYING INFLUENCE OF AQUEOUS MEDIA. Bhushan, Brij; Sawant, P. L.; Ramakrishnan, T. V.; Gore, M. S.; Kumta, U. S. (Bhabha Atomic Research Centre, Trombay, India). pp 279-93 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Experiments were conducted on the effects of gamma radiation on the stability of vitamin A acetate and β-carotene using aqueous dispersions containing carbohydrates, proteins, and surface active agents such as tween 80. In the freely dissolved state, the vitamin A acetate and β-carotene were highly susceptible to radiation damage. The products resulting from irradiation show absorption at relatively lower wavelengths and mask the spectral properties of untransformed β-carotene or vitamin A acetate thereby causing interference in the assessment of D_{10} values. In aqueous dispersions of β-carotene or vitamin A acetate containing sugars, tween 80, and albumin, the stability of β-carotene or vitamin A acetate to radiation was considerably increased. Possible mechanisms for dose modifying influence of aqueous media on radiation degradation of β-carotene and vitamin A are discussed. (H.L.W.)

28328 TOXICITY OF IRRADIATED MEDIA TO ISOLATED CELLS: A BIOCHEMICAL BASIS. De, A. K.; Aiyar, A. S.; Sreenivasan, A. (Bhabha Atomic Research Centre, Trombay, India). pp 499-509 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

The importance of "indirect" effects of ionizing radiation, mediated through stable radiolytic products, in bringing about a variety of biologically deleterious consequences have been brought to light in recent years. Studies on toxicity of irradiated media have been carried out with several types of biological systems: these include microorganisms as well as plant and mammalian cell cultures. Reviewing the more important observations in this area, the present report describes studies aimed at elucidating the toxicity of irradiated media (specifically, sucrose solution), at the cellular level, in terms of discrete biochemical events. On the basis of the findings, it is postulated that the deleterious effects of irradiated media in isolated cells, manifested in impairment of genetic, physiological and biochemical parameters, may derive from a primary interference with processes of energy production and conservation in the cell. (auth)

28329 FORMATION OF FREE RADICALS IN BIOPOLYMERS DURING THE ACTION OF IONIZING RADIATION AND LIGHT. Skvortsov, V. G.; Zhdanov, G. S.; Milinchuk, V. K. High Energy Chem. (USSR) (Engl. Transl.); 5: No. 5, 417-18(Sep-Oct 1971).

Translated from Khim. Vys. Energ.; 5: No. 5, 466-7(Sep-Oct 1971).

Results are presented from the EPR study of the kinetics for the accumulation of radicals in biological polymers: DNA, RNAase, and a synthetically prepared complex of 63% DNA + 37% RNAase. Curves for the accumulation of radicals in DNA during irradiation with only γ rays and during the simultaneous and sequential action of γ radiation and light are given. It is apparent that for the si-

multaneous action ~2.5 times more radicals are formed in DNA than for the sequential action. (D.H.M.)

28330 STRUCTURAL DISTURBANCES OF LYSOZYME AND RIBONUCLEASE AFTER γ-IRRADIATION IN A DRY STATE. Kaverzneva, E. D.; Maksimov, V. I.; Osipov, V. I. (Inst. of Organic Chemistry, Moscow). Biofizika; 16: No. 4, 581-8(Jul-Aug 1971). (In Russian).

Conformation and chemical changes of lysozyme and partly of ribonuclease A after γ irradiation in a dry state with doses of 30 Mrad were studied. There were found changes in dispersion of optical rotation, fluorescence spectra, ultra-violet spectra, and the content of tryptophan and other amino acids before and after fractionation of irradiated lysozyme. The observations performed earlier were supported by gel-filtration and solubility methods that show that the tertiary structure of lysozyme is significantly less disturbed than that of ribonuclease. Under equal doses of 30 Mrad, the latter shows total disturbance of conformation while the changes in lysozyme are of a more local character. The causes for higher stability of lysozyme were studied from the known structure of its molecule. It was found by the method of colorimetry without damaging protein and chromatographically after deep enzymatic hydrolysis, as well as by the studies of uv- and fluorescent spectra that tryptophan content decreased after γ irradiation. Some properties determined in totally irradiated lysozyme and obtained from it by the salting out of two fractions were found not to show additivity (DOR constants, UV-spectra, tryptophan content). The deviations from the native state are increased after fractionating. It is suggested from the results obtained that after γ irradiation of lysozyme in the dry state only ionization and primary changes in the state of the molecule proceed without essential structural disturbances. Only on subsequent solution and fractionating of the enzyme do the chemical changes of tryptophan residues and various conformational reconstructions take place. (auth)

28331 EFFECT OF X-RAY IRRADIATION ON CAPACITY OF NUCLEAR m-RNA FROM REGENERATING RAT LIVER TO STIMULATE PROTEIN SYNTHESIS IN CELL-FREE SYSTEM. Komar, V. E.; Nikitina, E. S. (Central Scientific-Research Roentgeno-Radiological Inst., Leningrad). Vop. Med. Khim.; 8: No. 1, 81-4(Jan-Feb 1972). (In Russian).

Nuclear m-RNA from regenerating rat liver stimulates protein biosynthesis in microsomal cell-free systems from normal liver. The highest activity was found for nuclear RNA, isolated from rat liver, 6 hours after partial hepatectomy. RNA activity decreased up to 24 hours, and within 48 hours it increased again. X-ray irradiation of animals at a dose of 15,000 R within 3 to 6 hours after partial hepatectomy led to inhibition of the RNA stimulating effect, which increased within 24 and became normal within 48 hours after hepatectomy. Activity of cytoplasmic RNA decreased within 6 and 24 hours after operation and increased again within 48 hours. (auth)

28332 UNSCHEDULED DNA SYNTHESIS IN HUMAN LEUCOCYTES AFTER EXPOSURE TO UV LIGHT, γ-RAYS, AND CHEMICAL MUTAGENS. Clarkson, Judith M.; Evans, H. J. (Western General Hospital, Edinburgh). Mutat. Res.; 14: No. 4, 413-30 (Apr 1972).

Unscheduled DNA synthesis in human peripheral blood lymphocytes has been compared following exposure of cells at various dose levels to uv light, γ-rays, methyl methanesulphonate (MMS) and nitrogen mustard (HN2). Lymphocytes in G_1 were exposed to these mutagens and then incubated in a medium containing [^{3}H] thymidine. For each mutagen the dose response and the temporal pattern of synthesis has been determined by scintillation counting of TCA (trichloroacetic acid)-extracted samples. In each case synthesis was found to initially increase with increasing dose, and following both types of radiation the initial increase was exponential. The system was found to be very sensitive to uv irradiation and unscheduled DNA synthesis has been detected at doses of 2 erg/mm^2, reaching a maximum at 40 erg/mm^2. The value obtained at dose levels above 40 erg/mm^2 was found to be constant for doses up to 5600 erg/mm^2 and then declined. Similar reductions in the amount of synthesis at high dose levels were also found with the chemical mutagens. For estimations of the duration of the reaction, cells were harvested at various times up to 22 h post-treatment. A parallel response was found for uv- and HN2-treated cells; for all doses considered, the reaction was largely completed within 6 h following exposure. This temporal pattern contrasted with the response following γ-irradiation and MMS treatment where synthesis continued for the whole of the incubation time considered. With γ-rays, the first 60 min following exposure was characterized by a phase of rapid synthesis, the amount of label incorporated increasing linearly over this period. The rate of incorporation between 1 and 22 h, however, although constant, was reduced to 25% of the early maximum rate. This biphasic response confirms and extends earlier studies and it is suggested that the early incorporation may be associated with the rejoining of radiation-induced single-strand breaks in the DNA. In the case of MMS a somewhat similar temporal pattern to that found with γ-rays was observed. Consideration of the initial rates of the reactions following treatments with each of the mutagens, indicates that the unscheduled synthesis of DNA is an enzyme-limited reaction, possibly involving a different enzyme in the case of each mutagen. (auth)

28333 RADIATION CHEMICAL STUDIES OF HEMOCYANIN IN OXYGEN-FREE MEDIA. Ke, Charles H.; Schubert, Jack (Univ. of Pittsburgh). Radiat. Res.; 49: No. 3, 507-20(Mar 1972).

The oxygen-carrying capacity of Busycon and Limulus hemocyanins is eliminated following irradiation of the protein with cobalt-60 γ rays in neutral, oxygen-free media. The loss of oxygen-carrying capacity of the protein is measured from the change of the characteristic copper band at 340 nm, before and after irradiation. The limiting $G(-O_2)$ values in the absence of scavengers are 0.026 and 0.044 for Busycon and Limulus hemocyanins, respectively. Radiation effects in oxygen-free media on Busycon and Limulus hemocyanins can either be enhanced or prevented by appropriate scavengers. The Busycon methemocyanin activity is restored by the hydrated electron, e^-_{aq}, and the secondary CO_2^- radical. The loss of oxygen-carrying capacity of hemocyanin by γ irradiation is attributed, therefore, to the OH radical that oxidizes the protein-bound copper at the active site, thus forming methemocyanin. The restoration of the oxygen-carrying capacity of Busycon methemocyanin is attributed to the reduction of cupric copper to the cuprous state by e^-_{aq}, and, in the presence of formate scavenger, to the secondary CO_2^- radical. While the cupric ion is reduced in Limulus methemocyanin as well, no restoration of its oxygen-carrying capacity is observed. From observations on scavenging, circular dichroism spectra, and direct assay of the cuprous ion concentrations it is concluded that the nature of the active sites at which copper is bound in the two hemocyanins is different. (auth)

Radiation Effects on Cultured Cells (External Source)

Refer also to abstracts 28440 and 28468.

28334 INFLUENCE OF RADIATION QUALITY ON THE PRODUCTION OF LETHAL AND NON-LETHAL DAMAGE IN MAMMALIAN CELLS. Berry, R. J. (Churchill Hospital, Oxford). Kerntech. Atomprax.; 13: No. 11, 503-9(Nov 1971).

Lethal effects of radiations of different quality can be measured by survival of mammalian cell reproductive capacity in vitro and in vivo. At low ionization densities, the dose-survival curve is of the cumulative effect type with a shoulder region indicating the relative ineffectiveness of small radiation doses. Hypoxia offers considerable protection against sparsely-ionizing radiations, and sub-lethal radiation damage is rapidly repaired when radiation doses are fractionated or protracted. As the ionization density of the radiation increases, the shoulder on the survival curve becomes smaller, hypoxia offers less protection, and less repair of sub-lethal damage is evident. At higher ionization densities, the dose-survival curve is of the single event type with no shoulder, hypoxia offers no protection against the radiation damage and no repair of sub-lethal damage is detectable. Radiations of the highest ionization densities (LET > 200 keV/μm) become progressively less effective per unit dose due to wasted ionization (overkill) within the irradiated cell. All the observed effects of radiations of mixed ionization density, such as fast neutrons (and π-mesons) cannot yet be predicted from knowledge of the physical distribution of sizes of individual ionizing events. The production of non-lethal radiation damage, when irradiation is given under hypoxic conditions, may have a different dependence upon radiation quality than does damage that results in the permanent loss of reproductive capacity in mammalian cells. (auth)

28335 CELL CULTURE AND RADIOBIOLOGY. Watanabe, Ikuo (National Inst. of Radiological Sciences, Chiba, Japan). Iden; 24: No. 5, 40-6(May 1970). (In Japanese).

Effect of radiation on cultured cells, especially the lethal action of radiation, appearing in the literature to date is reviewed. As one of the quantitative methods for the expression of the lethal action, the hit theory of Lea is described, mentioning the relation between irradiation dose and the number of cells killed, and factors of the cell itself that affect its sensitivity to radiation. Such factors include the stage of mitosis, oxygen content in the cells, the kind of radiation used which all affect the survival of the cells. Mention is

made on the relation between radiation and chemotherapeutics in the treatment of cancer cells, with cytobiological experiments using sensitizers like bromodeoxyuridine, chlorodeoxyuridine, or iododeoxyuridine, and problems on the compounds having SH group as radiation protectors. Studies on the breaking and rejoining of the DNA strand for the elucidation of the mechanism of recovery in survival from radiation damage and a specific phenomenon of proliferative death observed in cell death after irradiation are described with reference to the relation between cell death and individual death by irradiation. Mention is also made of experiments on the effect of radiation on DNA synthesis in cultured cells. (Japan)

28336 ANALYSIS OF RADIATION EFFECT ON CULTURED CELL (Culb-TC). Sakka, Masatoshi (Tohoku Univ., Sendai); Katsuta, Hajime; Takaoka, Satoko. Gan No Rinsho; 16: No. 6, 623-7(Jun 1970). (In Japanese).

By the use of a cinematographic technique, number and time of mitosis and behavior of postmitotic cells after irradiation were recorded for cultured cells and analyzed. The cells used were from a clonal cell line, Culb-TC, established in the Institute of Medical Science, University of Tokyo, from a rat hepatoma. The cultured cells were photographed at the speed of one frame every 2 min. A total of 4,167 frames were taken before irradiation and cinematography was started 30 min after irradiation of 800 R of ^{60}Co γ rays, taking 4,344 frames. The medium was renewed, 3,632 frames taken, and then the medium again renewed, and 4,388 frames taken. From the number of frames taken, the time elapsed after irradiation was calculated and expressed in minutes. Mitosis that occurred after irradiation was analyzed and compared with the control values. It was thereby found that the first mitosis started without delay after irradiation and the time distribution of mitosis was not prolonged by irradiation. The time required for the first mitosis (time required from P to T phase) was markedly prolonged by irradiation and the value was scattered. Although the first mitosis after irradiation occurred normally, the next mitosis was considerably delayed and the number of cells decreased gradually during this period. The second mitosis occurred 17,000 min after the end of irradiation and few mitoses occurred thereafter. Increase in cell number was exponential but the presumed doubling time (number measured with increased cells and not including loss of dead cells; i.e., corresponding to the potential doubling time of G. Steel) was greater than that before irradiation. (Japan)

28337 STOCHASTIC MODEL FOR CELL SURVIVAL UNDER IRRADIATION WITH EXPONENTIAL REPAIR TIME AND GENERAL DAMAGE TIME DISTRIBUTION. Gupta, P. C.; Bansal, B. N. L. (Inst. of Nuclear Medicine and Allied Sciences, Delhi. S. D. Coll., Muzaffarnagar, India). pp 431-41 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

A cell model of a single target has been postulated. A general distribution of independent probability density is assumed for the radiation damage. The repair or recovery is postulated to occur exponentially. Expressions for the probability of survival of an irradiated cell with constant repair rate and general damage time distribution have been obtained for an arbitrary instant of time. The scope of these expressions for application in practical cases have also been discussed in detail. (auth)

28338 CYCLIC CHANGES IN THE SURFACE STRUCTURE OF HUMAN ERYTHROCYTES INDUCED BY LOW DOSES OF X-RAYS. Sadarangani, S. H.; Phondke, G. P.; Sundaram, K. (Bhabha Atomic Research Centre, Trombay, India). pp 521-35 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Effects of low doses of x-rays on human erythrocytes in vitro have been studied. Post-irradiation changes in the electrophoretic mobility of these cells show an oscillatory behavior with radiation dose. The minima of the oscillations roughly correspond to unirradiated control. The sialic acid content of the cell surface also exhibits a cyclic pattern indicating migration of deep-seated sialic acid molecules towards the outer periphery simultaneously with the radiation induced degradation of the moiety. The viscoelastic properties of the membrane thus appear to be primarily affected by the radiation leading to conformational changes in the surface structure. (auth)

28339 CELL DEATH DUE TO INCORPORATED RADIOACTIVITY. Sivaramakrishnan, V. M.; Chandramouli, K. (Cancer Inst., Madras). pp 551-9 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Murine leukemia cells L 5178 Y were grown continuously in media containing tritiated thymidine at 3 different concentrations -0.025 μCi, 0.05 μCi and 0.1 μCi per ml and the growth and survival of the cells under these conditions investigated. The uptake of radioactivity into the cells at different times was measured. Compared to the controls, these cells proliferated at a retarded rate and then died off gradually. Typical morphological changes characteristic of radiation injury were observed. The total uptake of radioactivity greatly increased and the percent of survivors sharply diminished as the dose of tritiated thymidine and the time of incubation increased. The growth curves suggest reproductive death of cells at low concentrations of tritiated thymidine, but essentially interphasic death at high concentrations. The uptake and incorporation of tritiated uridine from the medium also resulted in the death of cells. But, on a comparative basis, the cell-killing efficiency of tritiated thymidine was found to be greater. This suggests that DNA is probably the primary site of radiation action. (auth)

28340 DEFICIENT DNA SYNTHESIS AND MITOTIC DEATH IN X-IRRADIATED HeLa CELLS. Hopwood, Larry Eugene. St. Louis; Washington Univ. (1971). 117p. University Microfilms Order No. 72-9345.

Thesis.

Mammalian cells, subjected to moderate doses of x-radiation, do not exhibit immediate morphological death, but undergo several rounds of division. The present study has made use of the experimentally favorable behavior of synchronously growing HeLa S3 cells after they have received a dose of 500 rads in G1: vitrually all the cells progress through the generation (generation 1) following the one in which they were irradiated, even though 85–90% cannot form macroscopic colonies. Resynchronization of the irradiated and control cultures at the first postirradiation mitosis or at the transition from G1 to S in the subsequent interphase permits quantitation of the radiation-induced effects on DNA synthesis in generation 1. The rate of thymidine incorporation throughout the S phase of generation 1 was found to be reduced in a dose-dependent fashion such that about 65% of the normal amount is incorporated after a dose of 500 rads. Autoradiographic analysis revealed that most of the cells synthesize a reduced amount of DNA, but that the reduction is much greater in some cells than in others. It had been shown previously that 25% of the cells are permanently arrested in mitosis at the end of generation 1, and subsequently disintegrate. These cells were separated from those that divide, and examined for the amount of DNA they had synthesized in generation 1. On average, only about 30% of the normal amount of DNA is replicated in the cells that suffer mitotic death. The cells that divide, in contrast, replicate about 80% of the normal amount. Thus the cells with the greatest deficiency of synthesis in the entire generation 1 population are those that become arrested in mitosis. These arrested cells, severely deficient in DNA, were also examined for their chromosomal configuration. Approximately 75% of the arrested cells possessed one of the following abnormal appearances: multipolar metaphase, fused chromatin, lagging chromosomes, or scattered chromosomes. These abnormal configurations appear in smaller numbers in the mitosis preceding the fatal one, as evidenced by their appearance at the first postirradiation mitosis. A working hypothesis is proposed to account for both the previously observed effects of irradiation on DNA synthesis in the irradiated generation (reduced rate of DNA synthesis, but normal amount of DNA replicated), and the deficient synthesis in the postirradiation generation described here. It is postulated that the DNA strand complementary to the strand with the initial lesion is replicated with a gap opposite that lesion, and that replication of this strand in generation 1 results in deficient synthesis. DNA synthesis in generation 1 is not deficient in cells that are irradiated with a 500 rad dose in G2. Since time-lapse cinemicrographic studies showed a higher incidence of interphase death for G2-irradiated cells, this result suggests that interphase death and mitotic death arise from different causes. (Diss. Abstr.)

28341 REPAIR IN X-IRRADIATED SYNCHRONOUS CHINESE HAMSTER OVARY CELLS. Winans, Lawrence Fielding. Fort Collins, Colo.; Colorado State Univ. (1971). 130p. University Microfilms Order No. 72-6453.

Thesis.

Cultures of mitotically selected synchronous Chinese hamster ovary cells were irradiated during mitosis, G_1 phase, and S phase in vitro with temperature carefully controlled. Colony formation

was used as the measure of survival. Repair of sublethal damage was studied by observing the increase in survival which occurred as two doses of irradiation were separated by incubation at 37C or 20C. Repair of potentially lethal damage was studied by observing the increase in survival occurring as the cells were held at 20C following a single dose of radiation. The maximum level of repair of sublethal damage by S phase cells increased with dose, but the half-time (15 to 20 minutes) for reaching that level was the same for a total dose of either 600 or 1000 rads. At 1000 rads this maximum survival for fractionated doses was eight to ten times the survival for the single dose; however, the maximum amount of repair did not reach the value expected if the shoulder of the survival curve had returned completely at the time the second dose was administered. The repair of potentially lethal damage had the same half-time as the repair of sublethal damage, but the magnitude of this repair was about one-half that of the repair of sublethal damage. The dose modifying factor (DMF), relative to a single dose at 37C, for repair of sublethal damage at 37C and 20C increased as survival levels decreased with the mean DMF values increasing from 1.13 to 1.21. Between 500 and 1000 rads, the maximum amount of repair of potentially lethal damage was expressed by a constant DMF of 1.08. For S phase cells, these studies suggest that repair of sublethal and potentially lethal lesions involve the same sites of damage. Cells in G_1 phase had capacity for repair of sublethal and potentially lethal damage with the same half-time as that for S phase, but showed a different magnitude of repair. The divided exposures at 37C had a DMF of 1.17 to 1.21. The DMF for repair of potentially lethal damage was 1.38 to 1.42. Mitotic cells did not show evidence of repair of potentially lethal damage, but they were capable of increasing their survival by progressing out of mitosis. Cells irradiated at 20C and held at 20C for 100 minutes showed a DMF of 1.3 to 1.4 relative to the 37C dose survival. At 250 rad, the survival ratio from the dose response curves was 2.5. This was the same value obtained within 100 minutes at 20C when the cells had started to progress into G_1 in an experiment to determine survival after 250 rad versus time at 20C after irradiation. (Diss. Abstr.)

28342 EFFECT OF IONIZING IRRADIATION ON SUSCEPTIBILITY OF McCOY CELL CULTURES TO CHLAMYDIA TRACHOMATIS. Gordon, F. B.; Dressler, H. R.; Quan, A. L.; McQuilkin, W. T.; Thomas, J. I. (Naval Medical Research Inst., Bethesda, Md.). Appl. Microbiol.; 23: No. 1, 123-9(Jan 1972).

The effect of graded doses of irradiation (cobalt-60) on the morphology of McCoy cells was analyzed, and 4,000 to 5,000 R was selected as a satisfactory dose for production of giant cells. The susceptibility of radiation-induced giant cells to chlamydial infection was compared with that of nonirradiated cells by using three strains of Chlamydia trachomatis and one of C. psittaci. Monolayers of giant cells were more susceptible than normal McCoy cells as indicated by greater numbers of inclusions (four- to eightfold) per unit area of monolayer, larger inclusions (four-fold greater in area), higher infective titers (1 log or more greater) of harvested cells, and greater ease of promoting a second cycle of growth. Graded doses of irradiation were applied also to mouse fibroblast (L) cells, and a similar increase in susceptibility to chlamydial infection was noted. It is concluded that giant cells produced by irradiation possess advantages over nonirradiated cells in culture for growth of Chlamydia. (auth)

28343 INDUCTION OF 8-AZAGUANINE-RESISTANT MUTANTS IN CULTURED CHINESE HAMSTER CELLS BY ULTRAVIOLET LIGHT: THE EFFECT OF CHANGES IN POST-IRRADIATION CONDITIONS. Arlett, C. F.; Harcourt, Susan A. (Univ. of Sussex, Eng.). Mutat. Res.; 14: No. 4, 431-7(Apr 1972).

The influence of caffeine (100 μg/ml) and incubation in salts medium ("liquid holding") was examined on the induction by uv light of mutants resistant to 8-azaguanine. Liquid-holding conditions enhanced survival and gave a significant but small reduction in mutation frequency. The influence of caffeine was seen to depend upon the length of time it was in contact with the cells. In a procedure where caffeine was present only during the period allowed for the expression of mutants, the induced mutant frequency was enhanced. Where caffeine was present for the complete post-irradiation incubation period, the frequency was reduced. The first of these experimental procedures is the more rigorous in that it reduces the opportunity for any possible interaction between the effects of the two purine analogues, caffeine and 8-azaguanine. The results are interpreted in terms of an error-prone component of the repair processes. (auth)

28344 DOSIMETRY FOR THIN BIOLOGICAL SAMPLES IRRADIATED BY NANOSECOND ELECTRON PULSES OF HIGH INTENSITY. McDonald, J.; Pinkerton, A.; Weiss, H.; Epp, E. R. (Sloan-Kettering Inst. for Cancer Research, New York). Contract AT(30-1)-3510. Radiat. Res.; 49: No. 3, 495-506 (Mar 1972).

Pulsed electron sources such as 600 kV field emission generators can deliver doses in excess of 10^6 rads in single pulses having duration times of a few nanoseconds. When these sources are used to irradiate thin layers of cells the measurement of absorbed dose is complicated by the associated high dose rates, the relatively low electron energy, and the thickness of the sample which may be only a few microns. In this laboratory, the problem of measuring absorbed dose was investigated by the use of thin discs of Pilot-B, a commercially available fast response plastic scintillator. The measurement of light pulses from the scintillator was accomplished with a nanosecond pulse integrator constructed at our laboratory. The determination of the dose absorbed by a cell layer made use of an extrapolation technique in which varying thicknesses of a scintillator disc were placed at the irradiation position in the same geometry as the cellular layer. A thin foil absorbed dose calorimeter was constructed to provide a calibration for the scintillator light output. Since the dynamic range of the scintillator system is quite large, it was possible to perform absorbed dose measurements over the large range of doses used for various radiobiological experiments. (auth)

28345 CHANGES IN POLYSOME ACTIVITY RELATED TO RADIATION-INDUCED MITOTIC DELAY IN SYNCHRONIZED ROOT MERISTEM CELLS. Kovacs, Charles J.; Van't Hof, Jack (Brookhaven National Lab., Upton, N. Y.). Radiat. Res.; 49: No. 3, 530-42(Mar 1972).

Earlier studies with synchronized plant cell populations suggested that radiation damage resulting ultimately in mitotic delay could be expressed either immediately or at some time after exposure. Whether damage resulted in an immediate cessation of progression through the mitotic cycle or whether cessation occurred latently was contingent on whether the protein requirements for further progression in the mitotic cycle were satisfied at the time of exposure. Experiments were designed to determine the effects of γ rays on protein synthesis and whether a relationship existed between radiation-induced mitotic delay and changes in rate of protein synthesis of synchronous populations. The results obtained demonstrated that an elevated rate of protein synthesis following γ irradiation is associated with mitotic delay. Elevated rates of polypeptide synthesis measured by sedimentation analysis, and protein synthesis measured autoradiographically, occurred only when irradiated populations were no longer making progress toward mitosis. The results suggested that: during mitotic delay an elevated rate of protein synthesis represents those proteins required for recovery; and that recovery occurs at the expense of further preparation for cycle progression, resulting in an impairment of division-oriented protein synthesis. (auth)

Radiation Effects on Microorganisms (External Source)

Refer also to abstracts 28400, 28439, and 28456.

28346 EFFECT OF THE NATURE OF A CARBON CONTAINING SOURCE ON THE RESISTANCE TO U. V. OF A. CHROOCOCCUM. Lagrange, C.; Kauffmann, J. (Univ., Caen, France). Compt. Rend. Soc. Biol.; 165: No. 3, 607-9(1971). (In French).

Sodium benzoate produces a reactivation phenomenon with Azotobacter chroococcum cells that were subjected to uv irradiation. (France)

28347 ANTAGONISM OF THE MICROFLORA OF THE SKIN IN GAMMA-THERAPY. Gridnev, V. A. (Khabarovsk Medical Inst., USSR). Med. Radiol.; 17: No. 1, 42-6(Jan 1972). (In Russian).

Gamma radiotherapy causes the development of a characteristic disturbance in the growth of the microflora of the skin, which becomes manifest at a focal dose of 2000 rad. A study of the activity of microbial associations on the irradiation fields, in respect to Escherichia coli, is recommended as an additional test for recognizing early forms of radiation reaction of the skin. (auth)

28348 GAMMA SENSITIVITY OF THE MAIN CORN MOULDS CONIDIA. INCIDENCE ON THE RADURIZATION OF CORN. Poisson, J.; Cahagnier, B.; Guilbot, A. Mycopathol. Mycol. Appl.; 45: No. 3-4, 193-209(1971). (In French).

In a study on the radiosterilization of cereals with γ rays, the radiosensitivity of spores of the main fungi causing molding of corn, i.e., Verticillium, Cephalosporium, Cladosporium, Asper-

gillus, and Penicillium, was investigated in order to improve technological trials or to explain some phenomena observed during experimentation on corn. The survival curves of the spores belonging to different species were established in relation to radiation doses of 20 to 300 Krad. These doses disinfect corn without reducing quality. Variations in the radiosensitivity of spores were studied in relation to different parameters which are likely to interfere during the treatment of corn: humidity, age of spores, refrigeration, heating, nature of substrate, and addition of fungicides. For example, a higher humidity rate increased radiosensitivity of the spores; a moderate heating before irradiation or a fungicide treatment had the same effect. A prolonged heating, higher temperatures, or freezing eliminated most radiosensitive spores. Very young and old spores were more radiosensitive than spores one to three months old. The radiosensitivity of spores varied with the nature of the substrate used during the radiation treatment. Radiosensitivity was higher on inert medium than on corn. (auth)

28349 MECHANISM OF RADIOSENSITISATION IN MICROORGANISMS. Nair, C. K. Krishnan; Pilgaokar, A. K.; Pradhan, D. S.; Sreenivasan, A. (Bhabha Atomic Research Centre, Trombay, India). pp 235-45 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Studies to elucidate mechanisms by which N-ethylmaleimide and iodoacetic acid enhance inactivation of Escherichia coli cells by gamma rays have been carried out. This radiosensitisation is seen only when cells are irradiated together with either chemical. E. coli B/r, a radioresistant strain, as well as E. coli Bs-1, a radiosensitive strain, can be sensitised to radiation by either compound indicating that interference in repair processes may not be a major factor in radiosensitisation. Sucrose density gradient analysis reveals that irradiation of cells with either N-ethylmaleimide or iodoacetic acid leads to increased number of strand scissions in the DNA molecule. These findings imply that the radiosensitisation is mainly brought about by intensification of ionising tracts in the suspending medium. (auth)

28350 BASIC CONSIDERATIONS IN MICROBIOLOGICAL CONTROL OF FOOD PRESERVATION BY RADIATION. Kumta, U. S.; Sreenivasan, A. (Bhabha Atomic Research Centre, Trombay, India). pp 247-63 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Certain aspects pertaining to radiation sensitivity of microorganisms in relation to their metabolic activities, problems of microbial hazards arising from suppression of competitive mechanisms of spoilage bacteria, and microbial safety and stability of irradiated foods are reviewed. Although Salmonellae are highly sensitive to radiation, endotoxins derived from them can be radioresistant. The susceptibility of the organism is also influenced by cultural and environmental factors. The differential response in survival kinetics between the metabolically active and the less active organisms leads to shifts in ecology of microflora, suppression of spoilage rates and enhanced shelf stability of radurised flesh foods. The 12D concept for destruction of Clostridium botulinum spores by thermal processing has been extrapolated to obtain radiation sterilization dose. The limitations of this concept and the scope for control of Cl. botulinum by combination treatments are indicated. (auth)

28351 INFLUENCE OF FERMENTATIVE PATHWAY ON RADIATION SENSITIVITY OF LACTIC ACID BACTERIA. Pradhan, P. G.; Nadkarni, G. B. (Bhabha Atomic Research Centre, Trombay, India). pp 265-77 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

It is recognized in several instances that adaptive synthesis of a particular enzyme is accompanied by induction of related proteins involved in the pathway. The growth of homofermentative Lactobacillus casei and Lactobacillus arabinosus on pentoses brings about a switch-over in the fermentative sequence with reduced aldolase activity and induced phosphoketolase. The survival curves of these organisms after gamma-irradiation (0-200 Kr) showed that pentose-adapted cultures were rendered more sensitive. The increased susceptibility was in keeping with the relative inactivation responses of the respective cleavage enzymes, phosphoketolase being more sensitive than aldolase. The relative responses of these two enzymes have been correlated with the involvement of thiol groups for activity. Cysteamine, a thiol group protector, increased the survival of pentose-grown cells to a larger extent than glucose-grown cultures. It also preserved phosphoketolase activity in vivo to a greater degree than aldolase. (auth)

28352 UV REPAIR MECHANISMS IN MYCOBACTERIUM SMEGMATIS. Rao, R. Nagaraja; Raj, C. V. Sundar; Ramakrishnan, T. (Indian Inst. of Science, Bangalore). pp 443-51 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Mycobacteriophage I3 is a generalized transducing phage active on Mycobacterium smegmatis SN2. Phage head is about 65nm long and the tail is about 70nm long. Uv sensitivity of phage I3 has been compared with lambda and T4 phages and is found to be relatively radioresistant. Uv sensitivity of M. smegmatis is compared with E. coli and is found to be relatively radioresistant. Uv irradiated phage and bacteria could be photoreactivated. Effects of acriflavine and caffeine on Uv irradiated phage and bacteria are discussed with reference to host cell reactivation. (auth)

28353 EFFECTS OF RADIATION DOSE ON DISINFECTION OF WATER BY γ RADIATION. Ryabchenko, V. A.; Elmanov, N. M. (Academy of Communal Economy, Moscow). Gig. Sanit.; No. 5, 99-100(May 1971). (In Russian).

Samples of water containing bacteria were irradiated with γ rays (^{60}Co) in doses from 2.5 to 50 kR, the dose rate ranging from 2 to 666 R/sec. Irradiation of enteric bacteria (those causing typhoid fever, paratyphoid fever, and dysentery) showed that the same radiation dose received by different microorganisms at different dose rates did not result in identical bactericidal effects. The larger the dose rate (R/sec) of radiation, the smaller the dose necessary to accomplish 100% disinfection of water containing certain bacteria. The effects of fractionated dose irradiation (rest periods of 5 min to 4 hr) were also noted. (K.S.W.)

28354 STUDIES ON RADIATION RESISTANCE IN SALMONELLA THOMPSON AND S. TYPHIMURIUM. Von Seefried, Adolf. Guelph, Ont. Univ. of Guelph (1968). National Library of Canada, Ottawa.

Thesis.

Repeated exposures of two species of Salmonella to gamma rays resulted in the production of mutants with increased radiation resistance, survivors being obtained after a radiation dose of approximately 1 Mrad. The radiation resistance was not transferable to other bacteria by conjugation and was resistant to acriflavin dyes, and therefore was the result of a chromosomal change and was not related to episomal DNA. The mutation to radiation resistance was accompanied by multiple genetic changes which were expressed in a variety of physiological changes. S. typhimurium cells became elongated, probably as a result of damage to the cell-division mechanism, and lost the ability to produce exotoxin in Brain Heart Infusion broth and gas from melibiose. The elongation of these particular bacteria and the dispersion of nuclear material throughout the cells was similar to physiological changes observed earlier in radiation-resistant mutant strains of E. coli. Radiation-resistant cells of S. thompson were much larger in overall size than the parent cells. The survival curve of this bacterium changed to a sigmoidal one upon development of resistance, suggesting that the distribution of nuclear material or some other physiological change in these cells necessitated multiple hits for cell death. Accumulation of hot-water extractable intracellular pool materials were not involved in the increased radiation resistance in S. thompson. However, a ninhydrin-positive intracellular protective compound appeared to be present in resistant cells which could not be extracted by hot water. This compound, which was not destroyed by boiling, was not present in the radiation sensitive strain, but could exert a protective effect when added to such cells during irradiation. This compound, having a molecular weight below 10,000, is believed to be a sulphydryl compound produced as a result of the blockage in methionine synthesis, but it has not yet been identified. This hypothesis is supported by the finding that the SH-binding compound, para-hydroxymercuribenzoate, increases the radiation sensitivity of the radiation-resistant mutant of S. thompson. (Diss. Abstr.)

28355 INTRACELLULAR DEVELOPMENT AND RADIOBIOLOGY OF BACTERIOPHAGE α. Strniste, Gary Freeman. University Park, Pa.; Pennsylvania State Univ. (1971). 77p. University Microfilms Order No. 72-9534.

Thesis.

Bacteriophage α, host Bacillus megatherium (tiberius), exhibits some unusual biophysical properties. Although it contains a double-stranded deoxyribonucleic acid (DNA) molecule its radio-

biological behavior is acutely sensitive, comparable to that found for single-stranded DNA containing phages. Furthermore, the response of intracellular developing α phage-host complexes to irradiation varies depending on the type of radiation. That is, in the case of ^{32}P decay, where the ^{32}P-atoms are restricted to the parental (infecting) particle, or uv light, there exists no decrease in sensitivity as the complex matures; however, for x or γ irradiation, there exists an immediate reduction in sensitivity following phage infection which gradually increases throughout development. Another unusual feature of α phage development is its reliance on one strand of its DNA compliment to act as primer for transcription and ultimate translation into protein products. This investigation concerned radiobiological experiments on various aspects of the molecular development of phage α (specifically DNA and RNA synthesis), conducted in an attempt to characterize this development and correlate it with the unusual radiobiological behavior of α phage. The investigation is presented in four related parts. The first part (I) concerned additional ^{32}P suicide experiments where it was shown that the capacity of the host, B. megatherium, to support α phage infection and complete development was not altered greatly as a consequence of ^{32}P decay when the ^{32}P-atoms were incorporated in the host nucleic acid. In another experiment it was shown that there existed an increasing stabilization to ^{32}P decay in α phage-host complexes when the ^{32}P label was incorporated into the progeny phage DNA, suggesting an increase in the number of critical targets as the complex matured. In part II it was shown that the sensitivity of intracellular phage α to the antibiotic rifampicin, an inhibitor of the DNA-dependent RNA polymerase, remained acute throughout the eclipse period. In another set of experiments it was shown that the progression of resistance of both early and late α phage-host complexes to γ rays was immediately halted by the addition of rifampicin, strongly suggesting that this decrease in sensitivity to γ irradiation was related to the transcription process. In part III, using an isolated rifampicin resistant mutant of B. megatherium, it was shown that transcription of all parts of the α phage genome was performed by at least part of the host RNA polymerase, specifically those subunits of the polymerase that determine the interaction with the antibiotic rifampicin. In the concluding part (IV) of this investigation the kinetics of intracellular phage α DNA synthesis were observed. It was shown that progeny phage DNA synthesis began almost immediately after infection and continued linearly throughout eclipse. Furthermore, it was shown that extensive host DNA degradation was absent after α phage infection, and in fact, it appeared that host DNA synthesis continued for some indefinite period after infection. (Diss. Abstr.)

28356 MUTAGEN STABILITY OF ALKYLATION-SENSITIVE MUTANTS OF BACILLUS SUBTILIS. Hill, T.; Prakash, L.; Strauss, B. (Univ. of Chicago). J. Bacteriol.; 110: No. 1, 47-55(Apr 1972).

A series of mutations of Bacillus subtilis, conferring sensitivity to methyl methanesulfonate (MMS), were transferred by transformation to a suppressible his^- stock. The introduction of certain sensitivity mutations prevented the ultraviolet- or MMS-induced, but not the spontaneous, reversion of his^- to his^+. Not all sensitivity mutations led to this resistance to mutagenesis; a strain with altered deoxyribonucleic acid (DNA) polymerase activity behaved almost normally with respect to its mutagen response, as did an excision-defective, ultraviolet-sensitive strain used as a control. One of the mutagen-stable strains responded to mutagenesis with nitrosomethylguanidine; another appeared stable even to this mutagen. All mutagen-stable strains had DNA polymerase and DNA ligase activity. (auth)

28357 PHOTOREACTIVATION, EXCISION, AND STRAND-REJOINING REPAIR IN R FACTOR-CONTAINING MINICELLS OF ESCHERICHIA COLI K-12. Paterson, M. C.; Roozen, K. J. (Oak Ridge National Lab., Tenn.). J. Bacteriol.; 110: No. 1, 71-80(Apr 1972).

Chromosomeless minicells are formed by misplaced cell fissions near the polar extremities of an Escherichia coli K-12 mutant strain. Resistance (R)-factor deoxyribonucleic acid (DNA) can be introduced into minicells by segregation from an R^+ (R64-11) derivative of the original mutant. We have assessed the ability of R^+ minicells to correct defects produced in their plasmid DNA by ultraviolet (uv) and gamma radiations. Minicells harboring plasmid DNA, in comparison with their repair-proficient minicell-producing parents, possess an equal competence to rejoin single-strand breaks induced in DNA by gamma rays, reduced capacity for the photoenzymatic repair of uv-induced pyrimidine dimers, and a total inability to excise dimers, apparently owing to a deficiency in uv-specific endonuclease activity responsible for mediating the initial incision step in excision repair. Assuming that the DNA repair properties of R^+ minicells reflect the concentration of repair enzymes located in the plasmid-containing polar caps of entire cells, these findings suggest that: the enzymes responsible for rejoining single-strand breaks are distributed throughout the cell; photoreactivating enzyme molecules tend to be concentrated near bacterial DNA and to a lesser extent near plasmid DNA; and uv-specific endonuclease molecules are primarily confined to the central region of the E. coli cell and thus, seldom segregate with R-factor DNA into minicells. (auth)

28358 COLONY MUTANTS OF COMPATIBLE NOCARDIAE DISPLAYING VARIATIONS IN RECOMBINING CAPACITY. Brownell, George H.; Walsh III, Richard S. (Medical Coll. of Georgia, Augusta). Genetics; 70: No. 3, 341-51(Mar 1972).

Colonial morphology mutants of Nocardia erythropolis were isolated following ultraviolet (uv) irradiation. The alleles rou-1/smo-1 were located by recombinant analysis and found to be linked to previously mapped characters. On the basis of recombinant class type patterns obtained from various selective characters it was postulated that the rou-1 allele may span a region of unique nucleotides in the Mat-Ce genome. Recombination frequencies of rou-1 and smo-2 bearing mutants of the Mat-Ce mating type were found to differ by over 1000 fold. Attempts to demonstrate that low recombination frequencies produced by the Smo mutants were due to Rec^- genes were unsuccessful. No increased sensitivity to either uv or x irradiation was observed by the Smo mutants. Acriflavine treatment of either Rou or Smo colony mutants failed to accelerate reversion or to alter the recombining potentials of the mutants. (auth)

28359 RESISTANCE OF BACTERIA TO THE ACTION OF RADIATION AND HEAT. Samoilenko, I. I.; Ivanov, K. K. (Inst. of Epidemiology and Microbiology, Moscow). Zh. Mikrobiol., Epidemiol. Immunobiol.; No. 2, 113-16(Feb 1972). (In Russian).

A comparative study of sensitivity of bacteria to gamma irradiation and heating at a temperature of 50°C was conducted. On various strains of Staph. aureus and E. coli (initial cultures and radioresistant mutants), it was shown that radioresistant cultures were also more resistant to thermic action. The mentioned correlation was seen in bacteria with different nucleotide DNA composition. (auth)

28360 DNA-REPAIRING ENZYMES. Fodor, I. Usp. Sovrem. Biol.; 71: No. 3, 331-52(May-Jun 1971). (In Russian).

This review article surveys the type of enzymes responsible for repairing DNA damage in microorganisms, recovery, and the basic injury induced in DNA by uv and ionizing radiations and other mutagens. Experimental results dealing with the DNA-enzyme reparation mechanism at various stages of the process are analyzed. The role of such enzymes in normal cells, in the genetic process with its integration of genes, in replication, and in mutation is discussed. (174 references) (tr-auth)

28361 RESEARCH ON SOME PHYSICAL AND CHEMICAL METHODS OF STERILIZATION OF MEDICO-SURGICAL MATERIALS. Magliano, E. M.; Braga, A.; Battezzati, G. (Univ., Milan). Ig. Mod.; 63: 499-517(1970). (In Italian).

Comparative studies were conducted in the sterilizing action of steam under pressure, ethylene oxide, and gamma rays on a particular surgical dressing (gauzes, tampons, and Vasenol impregnated with a dermatological paste), sealed in packings of various kinds (i.e., metal boxes, polyethylene bags, and paper-polyethylene bags). Numerous samples (nr. 1416) were subjected to a severe contamination with Staphylococcus pyogenes var. aureus, E. coli, and B. subtilis; the sterility tests were performed immediately after the treatment and at various intervals under unfavorable stocking conditions. The treatment with steam under pressure (1 atm, 120.6°C, 30 min), even though guaranteeing sterility, caused evident alterations in the material and in the package. Ethylene oxide (in mixture with 90% of carbon dioxide, 5.8 atm, 53°C, 60 min); and gamma rays (cobalt-60, 2.5 Megarad, 3 days) gave satisfactory results, both as to the sterilizing efficacy and as to the absence of alteration in the substratum. Sterilization by means of gamma rays, compared to that by ethylene oxide, permits a treatment of larger quantities of material, already packed in the final sealed envelope. This kind of sterilization has proved to be practical and safe. (auth)

28362 MICRODOSIMETRY. Spiers, F. W. (Univ. of Leeds, Eng.). pp 199-212 of Radiation Dosimetry. Vol. 1. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

Problems involved in measurements of the energy imparted to very small volumes (of 1 μm or less diameter) of biological materials exposed to different types of radiations are reviewed. It is pointed out that very low radiation doses and radiation dose rates are often involved in the measurements and the ionizing events in

a given small volume of tissue are infrequent. The limitations of the concept of absorbed dose and the relation of the linear energy transfer of charged particles to the radiation dose absorbed are discussed. A spherical gas-flow proportional counter with tissue-equivalent walls that operates at a low gas pressure so that it simulates a very small mass of tissue is described and applications for measurements of the absorbed dose with respect to local energy density for a 1 μm sphere irradiated with different doses of ^{60}Co γ radiation and 1 MeV neutrons are reported. (C.H.)

28363 REPAIR OF PYRIMIDINE DIMER DAMAGE INDUCED IN YEAST BY ULTRAVIOLET LIGHT. Resnick, Michael A.; Setlow, Jane K. (Oak Ridge National Lab., Tenn.). J. Bacteriol.; 109: No. 3, 979-86(Mar 1972).

Crude extracts from ultraviolet (uv)-irradiated yeast cells compete with uv-irradiated transforming deoxyribonucleic acid (DNA) for photoreactivating enzyme. The amount of competition is taken as a measure of the level of cyclobutyl pyrimidine dimers in the yeast DNA. A calibration of the competition using uv-irradiated calf thymus DNA indicates that an incident uv dose (1,500 ergs/mm^2) yielding 1% survivors of wild-type cells produces between 2.5×10^4 to 5×10^4 dimers per cell. Wild-type cells irradiated in the exponential phase of growth remove or alter more than 90% of the dimers within 220 min after irradiation. Pyrimidine dimers induced in stationary-phase wild-type cells appear to remain in the DNA; however, with incubation, they become less photoreactivable in vivo, although remaining photoreactivable in vitro. In contrast, exponentially growing or stationary-phase uv-sensitive cells (rad2-17) show almost no detectable alteration of dimers. We conclude that the uv-sensitive cells lack an early step in the repair of uv-induced pyrimidine dimers. (auth)

28364 DEOXYRIBONUCLEIC ACID-PROTEIN RATIO AND RADIORESISTANCE IN MICROCOCCUS RADIODURANS. Freedman, M. L.; Bruce, A. K. (State Univ. of New York, Buffalo). J. Bacteriol.; 109: No. 3, 1310-12(Mar 1972).

Cessation of exponential growth of Micrococcus radiodurans increased x-radioresistance while either increasing or decreasing the deoxyribonucleic acid-protein ratio. A table is presented to show the effects of culture condition on cellular contents of DNA and protein and on x-ray resistance. (H.L.W.)

28365 INDUCTION BY CYANIDE, DINITROPHENOL, AND TRINITROPHENOL OF GROWTH INHIBITION AND OF RECOVERY FROM FAR-ULTRAVIOLET KILLING IN ESCHERICHIA COLI B: RELATIONSHIP TO PHOTOPROTECTION. Lakchaura, Bala D.; Jagger, John (Univ. of Texas, Dallas). Radiat. Res.; 49: No. 3, 631-46(Mar 1972).

Pretreatment with near-ultraviolet (334 nm) light (photoprotection treatment), or posttreatment with potassium cyanide or 2,4-dinitrophenol, inhibits growth of Escherichia coli B and increases its survival after far-ultraviolet (254 nm) irradiation. In general, recovery is proportional to the extent of growth inhibition, whether this is induced by photoprotection treatment, by cyanide, or by dinitrophenol. Cyanide and dinitrophenol recovery overlap with photoprotection. Posttreatment with 2,4,6-trinitrophenol increases the survival of far-ultraviolet-irradiated cells, but inhibits growth less, for the same survival, than the other treatments. The actions of trinitrophenol and photoprotection are additive, and appear to be independent. It is concluded that cyanide, dinitrophenol, and photoprotection affect far-ultraviolet damage primarily through the common mechanism of growth inhibition, which permits more time for dark repair. Trinitrophenol increases far-ultraviolet survival by some unknown mechanism. (auth)

28366 GENETIC ANALYSIS OF X-RAY-INDUCED HALF-SECTORED COLONIES OF SACCHAROMYCES CEREVISIAE. Johnston, John (Univ. of California, Berkeley). Radiat. Res.; 49: No. 3, 558-62(Mar 1972).

Phenotypic analysis of x-ray-induced half-sectored colonies of diploid strains respectively heterozygous for linkage groups of fragments 1 and 2 and genetic analysis for the latter group were performed. Results agree with those obtained for chromosomes II and VII and support proposals that mitotic crossing over is the predominant mechanism of induced sectoring but that nonreciprocal conversion also occurs. The x-ray dose of 12.5 krad, that results in 86% survival, increases the rate of mitotic segregation by approximately 100-fold over the spontaneous rate. (auth)

Radiation Effects on Plants (External Source)

Refer also to abstracts 28308, 28400, 28439, 28456, and 29175.

28367 (AD-734368) EFFECTS OF BETA RADIATION ON PLANT GROWTH. Final Report. Schulz, R. K. (California Univ., Berkeley. Dept. of Soils and Plant Nutrition). Sep 1971. Contract DAHC20-70-C-0215. 114p. NTIS.

Plant growth chamber experiments were carried out where lettuce, wheat and pea plants were contaminated with yttrium-90 by brief immersion of the foliage in solutions containing various concentrations of yttrium-90. Grain production and seed viability of the wheat was reduced 50% when the foliage was contaminated with yttrium-90 at the rate of about 3 micro curie per square centimeter. Pea pod production was reduced 50% when the contaminant was deposited on the foliage at about 4 micro curie per square centimeter. A 47% yield reduction of vegetative growth was obtained on the lettuce at the highest amounts of yttrium-90 applied, 37 micro curie per square centimeter. When a contaminant level of 10 micro curie per square centimeter was reached visual abnormalities in plant growth appeared. Field experiments were carried out to investigate the effect of beta radiation on the growth of wheat, lettuce and corn. Wheat grain production was severely reduced when 6.6 mCi per square foot of yttrium-90 was applied. Lettuce yields were reduced significantly only at the highest treatment level of 59.4 mCi yttrium-90 per square foot and this corresponded to 9,300 rads at the plant surface near the apical meristem. Some abnormalities were visually noticeable on the lettuce at 6.6 mCi per square foot treatment level. Corn yield was not reduced and plant appearance was not changed in any of the treatments which ranged up to 71.3 mCi per square foot. The apical meristem of the corn plant was protected by about 1 cm of tissue, hence it received very little ionizing radiation. (auth) (NTIS)

28368 (EUR-4718) SHORT-TERM EFFECTS OF RADIATION, THEIR DIAGNOSTIC AND TREATMENT. Annual Report, 1970. (European Atomic Energy Community). 1972. 70p. (In English and French). Dep. NTIS (U. S. Sales Only). EUR FB 100,-.

Results are reported from studies on the therapy of secondary disease in whole-body irradiated dogs. The effectiveness of a number of immunosuppressive drugs (6-mercaptopurine, daunomycin, methotrexate, hydroxyurea, hydrocortisone, 6-aminochrysone, and azathioprine) and of antilymphocyte serum in the prevention of secondary disease was evaluated. Results of studies on histocompatibility in Rhesus monkeys; the purification of hemopoietic stem cells by gradient density centrifugation; the effects of pre-treatment of bone marrow recipients with antilymphocyte serum; the biological effects of radioisotopes incorporated into rapidly and slowly dividing cell systems; and the characterization of hemopoietic stem cells are reported briefly. (auth) (TSS)

28369 EVALUATION OF RELATIVE BIOLOGICAL EFFICIENCY (RBE) OF ACCELERATED ELECTRONS AND γ-RAYS DURING IRRADIATION OF POTATO SEEDS. Mezentsev, M. V. Tsitol. Genet.; 5: No. 5, 399-402(Sep-Oct 1971). (In Russian).

Potato seeds from self-pollination of the Tsentifolia variety were subjected to γ irradiation with ^{60}Co in doses of 10, 20, and 30 kR at dose rates of 50, 500, and 5000 R/min and to irradiation with accelerated 1 MeV electrons in doses of 10, 20, and 30 kR at a dose rate of 5000 R/min. Chromosome aberrations were taken into account in anaphases of the first mitosis. The effect of electrons is equal to that of γ irradiation at a dose rate of 5000 R/min. Germination and survival tested in doses of 10 and 20 kR at a dose rate of 5000 R/min proved to be the same in electron and γ irradiation. (auth)

28370 DEPENDENCE OF THE DURATION OF THE MITOTIC CYCLE STAGES IN CREPIS CAPILLARIS ROOT MERISTEM CELLS ON A DOSE OF X-RAY IRRADIATION. Kaznadzei, V. V. Tsitol. Genet.; 5: No. 5, 416-20(Sep-Oct 1971). (In Russian).

A relation between the duration of the G_2 and S stages of the mitotic cycle in root meristem cells of Cr. capillaris and a dose of x rays was studied by means of ^{3}H-thymidine method. The duration of the G_2 increases in proportion to the dose. The delay of the cell cycle reflects the formation of the block and partial synchronization of cells at the end of the G_2 period. The duration of the S period increases unproportionally to the dose and is of an exponential nature. The delay in the S period reflects a desynchronizing effect of the radiation on synthesis. (auth)

28371 COMPARATIVE STUDY OF IONIZING RADIATION EFFECT ON GROWTH, DEVELOPMENT, AND VARIABILITY OF DIFFERENT SPECIES OF COTTON IN M_1. Rakhimkulov, R. Yu.; Mamedov, K. Tsitol. Genet.; 5: No. 5, 427-31(Sep-Oct 1971). (In Russian).

The effect of γ irradiation on seeds of cotton of Gossypium hirsutum and G. barbadense species was studied. The difference in periods of development stages in different species of cotton is established. The frequency of appearance of changed forms is in a linear dependence on a radiation dose. (auth)

28372 EFFECT OF X-RAYS AND γ-RAYS ON GERMINATING RATE AND SURVIVAL OF SOYBEAN PLANTS AS DEPENDENT ON GENOTYPE. Boreiko, A. M. Tsitol. Genet.; 5: 432-5(Sep-Oct 1971). (In Russian).

The effect of different doses of x rays and γ rays on germinating rate and survival of soybean plants was studied in M_1 of 16 varieties. A specific reaction of different varieties on the same doses of the mutagens used and different action of mutagen factors (mutagen dose) on the same variety is shown. An assumption is advanced on a genetic control of the specific reaction of the varieties to the effect of mutagens. (auth)

28373 EFFECT OF MUTATED GENES ON THE GERM CELL FORMATION IN PISUM. Gottschalk, W.; Baquar, S. R. (Univ., Bonn). Pak. J. Sci. Ind. Res.; 14: No. 3, 223-7(Jun 1971).

The meiotic behavior of an x-ray induced mutant of Pisum sativum was analyzed. The recessive gene causes a strong reduction of chiasmata frequency resulting in a varying number of univalents in the pollen mother cells. The later meiotic stages are highly abnormal and lead to genomically unbalanced nonfunctionable germ cells. The mutant is sterile in both sexes. In the light of the present finding, the gene action system of the meiosis in Pisum is discussed. A total of 39 genes have so far been controlling this fundamental biological process. (auth)

28374 GENETIC BASIS OF THE RESISTANCE OF PLANTS TO FUNGUS DISEASES. Vozdova, G.; Bartos, P. (Inst. of Genetics and Plant Breeding, Prague). Genet. Slechteni; 7: No. 4, 1-14(1971). (In Czech).

A survey is presented on the development of the studies concerning genetics of resistance, and explains fundamental notions of resistance. Further, the following problems are discussed: genetic system providing resistance of plants; genetic systems which participate in the formation of the variability of the fungi; relations between the host and pathogen and also the evolution of these relations; and genetic bases of breeding for resistance. (auth)

28375 EFFECT OF X RAYS ON TUMOR TRANSFORMATION OF TOPINAMBOUR RHIZOMES CELLS BY AGROBACTERIUM TUMEFACIENS. Parrot, Francoise (Paris Univ.); Jonard, Robert. Compt. Rend., Ser. D; 273: No. 20, 1809-11(15 Nov 1971). (In French).

Topinambour rhizome fragments exhibit larger tumors when irradiated with relatively small doses of x rays and inoculated with Agrobacterium tumefaciens than when nonirradiated. In contrast, the proliferation of irradiated tissues outside the inoculated zone is partially inhibited. (France)

28376 EFFECT OF POST-RADIATION CULTIVATION CONDITIONS ON BIOCHEMICAL PROCESSES IN IRRADIATED COTTON PLANTS. Nazirov, N. N. (Inst. of Experimental Plant Biology, Tashkent). Uzb. Biol. Zh.; No. 3, 3-7(1971). (In Russian).

Cotton seeds were exposed to 10 kR γ radiation delivered at a dose rate of 34 R/sec. The effects of post-radiation cultivation conditions on cotton plants grown from the seeds were studied. The catalase and peroxidase activities in the leaves were increased. An artificially shortened day resulted in comparatively high peroxidase activity. The activity of some enzymes in the plants was highly sensitive to pH conditions during the cultivation stage. The glutathione content was measured during the leaf and flowering stages. The rate of incorporation into the plant of ^{32}P was determined in specimens under various cultivation regimes. (K.S.W.)

28377 EFFECT OF PRE-SOWING GAMMA IRRADIATION ON THE AMINO ACID COMPOSITION OF GLOBULINS OF COTTON SEED. Ibragimov, A. P.; Yunuskhanov, Sh.; Tuichiev, A. V. (Inst. of Biochemistry, Tashkent). Uzb. Biol. Zh.; No. 3, 8-10(1971). (In Russian).

Seeds of cotton were irradiated with ^{60}Co γ at a level of 16 R/sec, and then were sown with controls in experimental plots. At the end of the growing season the seeds were assayed for amino acid content by chromatography, electrophoresis, and dinitrophenylation. Globulin fractions and certain peptides were analyzed separately for individual amino acids. (K.S.W.)

28378 BIOLOGICAL PROPERTIES AND OILINESS OF SEEDS OF RADIOMUTANTS OF THE COTTON PLANT. Egamberdiev, A.; Paiziev, P.; Skvortsova, S.; Feodoridi, N. (Inst. of Experimental Plant Biology, Tashkent). Uzb. Biol. Zh.; No. 3, 18-19(1971). (In Russian).

The effect of radiation on the variability of characteristics in the cotton plant and the production of new genetic strains were studied. Cotton bolls of different developmental stages were irradiated with a γ source for 1.5 and 2 kR doses. The seeds produced from the irradiated material were analyzed for six high molecular weight fatty acids. Some mutants showed no change in fatty acid content, and some mutants possessed high palmitic and linoleic acid contents. (K.S.W.)

28379 EFFECT OF GAMMA RAYS ON FERTILIZATION OF THE COTTON PLANT. Vlasova, N. A.; Kalyagina, L. G. (Inst. of Experimental Plant Biology, Tashkent). Uzb. Biol. Zh.; No. 3, 64-7(1971). (In Russian).

The process of fertilization was studied in cotton plants which were grown from irradiated seed. Dry cotton seeds were exposed to γ radiation for total doses of 3, 10, and 20 kR. A number of anomalies were observed; with increase in the radiation dose the number of anomalies also increased, promoting sterility. (K.S.W.)

28380 EFFECT OF TEMPERATURE AND GAMMA IRRADIATION ON CHANGES IN CARBOHYDRATE COMPOSITION OF SOME POTATO VARIETIES DURING STORAGE. Filep, G. (National Inst. for the Testing of Agricultural Varieties, Budapest); Kaposztassy, E. Novenytermeles; 20: No. 4, 289-301(Dec 1971). (In Hungarian).

Potato tubers treated with 10 krad γ radiation for sprout inhibition were examined for changes in carbohydrate composition during storage. The effect of storage temperature on changes in carbohydrate composition was studied. Soluble carbohydrate content was found to increase more rapidly in Gülbaba variety potatoes stored at lower (5°C) temperature than in samples kept at 18°C; the latter, however, showed a high rate of deterioration after twelve weeks of storage. With both temperatures sugar accumulation was of a lower rate in irradiated samples than in controls, and vitamin C content decreased to a higher extent in irradiated tubers than in controls. In later phases of storage the difference gradually disappeared and in April vitamin C content was almost normal in treated tubers. (TSS)

28381 RADIOSENSITIVITY OF DNA IN S PHASE. Tikoo, S. K.; Aravindan, K. V.; Sharma, B. (Indian Agricultural Research Inst., New Delhi). pp 141-9 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

It has been suggested that nitroso-compounds specifically act at the fork of the replicating DNA. In barley seeds DNA synthesis starts after 16 hours from the onset of soaking of seeds in water at 23°C. Seeds in this period were treated with N-nitrosomethyl urea (0.01%), 1,4-bis diazoacetyl butane (0.3%), and gamma-rays (10,20 kR), and compared with dry-seed treatments. Cytological study of chromosomal aberrations at the first mitotic division revealed that all three agents induced more chromosomal damage when applied in the period of DNA synthesis than in resting cells. The increase in the mutagenic efficiency as a result of pre-soaking was the highest in case of gamma-rays. These findings suggest that increased sensitivity of replicating DNA is not restricted to the nitroso-compounds alone, but to other chemical mutagens and ionizing radiations also. (auth)

28382 ROLE OF POLYPHENOL OXIDASE IN GAMMA IRRADIATION INDUCED BROWNING OF BANANA FRUITS. Thomas, Paul; Nair, P. M.; Sreenivasan, A. (Bhabha Atomic Research Centre, Trombay, India). pp 203-16 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Exposure of preclimateric banana fruits to gamma rays exceeding 50 krad resulted in skin browning and fruit splitting. Irradiating the fruits under anoxia did not significantly reduce this radiation injury indicating that factors other than ozone formed during irradiation in air are also responsible for the radiation damage. Very high polyphenol oxidase activity was observed in both pulp and skin tissues of bananas exposed to gamma rays. While the "catecholase" activity of the enzyme increased with increasing doses of radiation, the cresolase activity showed an increase up to 100 krad and decreased at 200 and 500 krads. The radiation augmented increase in polyphenol oxidase activity was found to be due to an activation rather than a de novo synthesis. Altered cell permeability and increased enzyme activity on irradiation are implicated as the causes for browning in irradiated bananas. A good correlation between the polyphenol oxidase activity and skin discoloration in irradiated banana fruits has been observed. (auth)

28383 EVIDENCE FOR THE ACTIVATION OF POTATO CHROMATIN FOR TRANSCRIPTION BY GAMMA IRRADIATION. Nair, P. Madhusudanan; Sreenivasan, A. (Bhabha Atomic Research Centre, Trombay, India). pp 217-33 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Dormant buds of potatoes are incapable of DNA or RNA synthesis. Previous studies have shown that 10 krad gamma irradiation has caused an activation in the synthesis of DNA, RNA and protein. The capacity for radiation induced synthesis of DNA and RNA lasted only for 2 hrs in irradiated buds. A comparative study on the chromatin from irradiated and unirradiated buds has shown that only the chromatin from irradiated buds was active as template for E. coli RNA polymerase. 40 μg of chromatin DNA showed maximum synthesis of RNA. Chromatin isolated from buds within ½ hr after irradiation showed maximum template activity. After 2 hrs no RNA synthesis was observed. It has been shown that plant auxin IAA can reverse the sprout inhibition obtained by gamma irradiation only when the potatoes were treated with IAA within 6 hrs after irradiation. The transient activation of chromatin caused by irradiation may have a significant role to play in the sprout inhibition of potatoes. (auth)

28384 EFFECTS OF CENTRIFUGATION AND SUCROSE TREATMENT ON THE MUTAGEN SENSITIVITY IN HORDEUM VULGARE, CICER ARIETINUM, AND PISUM SATIVUM. Singh, C. B.; Dhar, R. D.; Kaul, A. K. (Indian Agricultural Research Inst., New Delhi). pp 295-301 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Dry seeds of barley were treated with gamma rays (20 kR) and nitroso-methyl urea (0.005, 0.01 and 0.02 per cent concentrations) and centrifuged at 5, 10, 15 and 20 thousand revolutions per minute for 15 minutes. Data on the germination, survival, shoot and root growth inhibition, and mitotic abnormalities were recorded as an index of the mutagenic sensitivity. Results revealed that reduction in the germination and survival increased with centrifugation more or less linearly with the speed. The shoot (in barley) and root(in gram) growth of 15-day old seedlings did not show any consistency with the treatments. The increased frequency of chromosomal aberrations recorded in root-tip cells suggests that post mutagen-centrifugation treatments might increase the number of sites for the action of mutagens in the interphase. The pretreatment of water soaked seeds (for 12 h.) with 10 percent sucrose solution (for 30 min) followed by Nitroso-Methyl Urea and Nitroso-ethyl-Urea treatments in barley, gram and peas appeared to effect the mutagen sensitivity, probably through the rapid penetration of the mutagen. (auth)

28385 RELATIVE ROLES OF GENOTYPIC AND PHENOTYPIC FACTORS IN DETERMINING SENSITIVITY TO MUTAGENS IN RICE. Palanichamy, K.; Singh, V. P.; Siddiq, E. A. (Indian Agricultural Research Inst., New Delhi). pp 303-23 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Three groups of varieties of Oryza sativa were used. Dry seeds of each variety were gamma-irradiated at a dose rate of 2.5 kR per min. For treatment with ethyl methanesulfonate seeds were presoaked in water for 20 hrs. Seedling injury in terms of growth rate was measured on the tenth day after planting and estimates were made of pollen fertility and seed sterility. Other characteristics studied were amylose content, alkali digestion, hairiness in grain apex, and length/breadth ratio of leaf. The results are tabulated and a discussion is presented of correlations between genotype and phenotypic differences induced by EMS and radiation. (H.L.W.)

28386 POST-IRRADIATION EFFECTS ON THE GROWTH AND CHLOROPHYLL DEVELOPMENT OF DOLICHOS LABLAB AND ARACHIS HYPOGEA MESOPHYLL TISSUES IN CULTURE. Arya, H. C.; Batra, Amla; Kant, U. (Univ. of Rajasthan, Jaipur, India). pp 337-46 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

The post-irradiation behavior of mesophyll tissues of Dolichos lablab and Arachis hypogea to various dosages of gamma-radiation from ^{60}Co was studied. The tissues were isolated from cotyledons and maintained on modified High Salt, and Murashige and Skoog media, respectively. The dosages from 25 to 100R did not affect any of the tissues apparently, but from 200 to 5000R retarded growth and chlorophyll of the tissues supplemented with sucrose but the tissues with mannitol in the media remained unaffected. Still lower doses of 5 to 15R enhanced growth and chlorophyll of tissues grown on sucrose and mannitol supplemented media. All the sets of irradiated tissues were grown to study the effect of light, temperature, hydrogen-ion concentration, auxins, vitamins, and iorganic nutrients. The irradiated tissues showed recovery and increased growth and chlorophyll formation. However, irradiated tissues grown on mannitol supplemented media showed only limited growth and chlorophyll development. (auth)

28387 SOME PHYSICO-CHEMICAL CHANGES IN GAMMA-IRRADIATED WHEAT. Ananthaswamy, H. N.; Vakil, U, K.; Sreenivasan, A. (Bhabha Atomic Research Centre, Trombay, India). pp 347-71 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Increase in initial reducing sugars and diastatic activity in irradiated wheat (20 to 200 krads) can be attributed to degradation of starch to oligosaccharides; the radiolytic breakdown resembles the process of alpha-amylolysis. Isolated starch and its components amylose and amylopectin, are more susceptible to alpha or beta-amylase action on irradiation. A shift in the molecular weight distribution to lower values in irradiated wheat (1 Mrad) proteins is reflected in higher rate of autolysis in irradiated wheat flour and in increased susceptibility of isolated wheat proteins to protease action. Certain observed changes in the rheological properties of irradiated wheat correlate with improved baking quality in terms of loaf volume and crumb grain. There is impairment in the biosynthesis of gibberellic acid (GA) that affects germination of irradiated seeds. Seedling growth and alpha-amylase synthesis in aleurone layers are also affected. Exogenous treatment of seeds with GA reverses radiation induced physiological effects at low levels. (auth)

28388 RESPONSE OF BARLEY AND PEA VARIETIES VARYING IN RADIOSENSITIVITY TO ALKYLATING AGENTS. Sharma, B.; Bansal, H. C.; Aravindan, K. V.; Tikoo, S. K. (Indian Agricultural Research Inst., New Delhi). pp 463-76 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Radiosensitivity was determined in 40 varieties each of barley and pea. Varieties with high, medium and low radiosensitivity were treated with gamma-rays, N-nitrosomethyl urea (NMU) and ethylene imine (EI), and the mutations were scored in the M_2 generation. In general, the radiosensitive varieties gave more mutations even with lower doses of gamma-rays as compared to the radioresistant varieties treated with very high doses of gamma-rays. There were significant differences in the mutation rates obtained with different varieties in each group of radiosensitivity. Moreover, the varietal response toward NMU and E^I was different in all three groups of radiosensitivity. The results are discussed in the light of information available about the repair processes of radiation- and chemical damage(s) leading to lethality and mutation. (auth)

28389 SWELLING AND CONTRACTION OF BEAN MITOCHONDRIA AS AFFECTED BY TISSUE IRRADIATION. Joshi, V. G.; Gaur, B. K. (Bhabha Atomic Research Centre, Trombay, India). pp 511-20 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Ionizing radiations have been earlier suggested to uncouple oxidative phosphorylation in animal and plant tissues. Further evidence in this direction has been obtained by studying mitochondrial swelling and contraction-properties dependent on energy status and structural integrity. Mitochondria were extracted from normal and gamma-irradiated hypocotyl segments of 4-day old bean seedlings. Swelling and contraction were initiated by supplying buffered KCl and some oxidizable substrate or ATP respectively. The changes in turbidity were then recorded spectrophotometrically in the presence and absence of 2,4-dinitrophenol (DNP). Radiation enhanced the swelling per se as well as its rate. The contraction, on the other hand, was markedly reduced. While the effect of DNP alone was qualitatively similar

to that of radiation, it was lowered in the pre-irradiated tissue. When irradiated at doses higher than 500 kR the DNP proved ineffective. (auth)

28390 GAMMA-IRRADIATION AND NUCLEAR-CYTOPLASMIC RELATIONSHIPS IN ACETABULARIA MEDITERRANEA. Netrawali, M. S. (Bhabha Atomic Research Centre, Trombay, India). pp 537-50 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Exposure of Acetabularia mediterranea cells to increasing doses of gamma radiation results in graded retardation of growth and morphogenesis. It was found that enucleated cells, which can grow for several weeks and regenerate a cap normally, are as sensitive to gamma-radiation as whole cells. Cytoplasmic syntheses of protein, RNA as well as DNA in enucleated cells are suppressed to the same extent as in whole cells following irradiation. These observations suggest that the nucleus cannot be the main target of radiation injury in this organism. Gamma irradiation at a dose which inhibits morphogenesis and growth does not change the buoyant density of chloroplast DNA in cesium chloride gradient, whereas, mitochondrial DNA is almost completely destroyed. This indicates that mitochondrial damage may be a major factor in determining sensitivity of this cell to ionizing radiations. The findings are discussed in relation to nuclear-cytoplasmic relationships. (auth)

28391 EFFECTS OF IONIZING RADIATION ON THE DEVELOPMENTAL MORPHOLOGY OF THE ANDROECIUM OF COLEUS BLUMEI BENTH., INCLUDING MICROGAMETOGENESIS. Shoffstall, George Carson Jr. University Park, Pa.; Pennsylvania State Univ. (1971). 92p. University Microfilms Order No. 72-9525.

Thesis.

The effects of ionizing radiation on the developmental morphology of the androecium of Coleus blumei Benth., up to and including microgametogenesis, were studied. Cuttings were taken from a single specimen of Coleus. Two plants were maintained as controls and five plants were subjected to gamma radiation at a dosage rate of 176 R/hr for 25 hours. Flowers and inflorescence tips from both irradiated and unirradiated plants were embedded, serially sectioned, and stained in safranin and fast green. Observation of serial sections was restricted to the androecium. Development, structure, and fate of the Coleus anther walls were similar under unirradiated and irradiated conditions. The epidermis of the immature anther delimits the meristematic activity which produces the anther primordium. Anticlinal divisions occur in the epidermis during enlargement of the anther. The hypodermal cell(s) in each lobe of the anther divides periclinically to form an archesporial cell. The tangential division of the archesporial cell results in an outer primary parietal cell and inner sporogenous cell. The primary parietal wall layer development follows the dicotyledonous type whereby the outer secondary parietal layer gives rise to the endothecium and an ephemeral middle layer. The inner secondary parietal layer gives rise to the secretory tapetum. The sporogenous cells ultimately undergo division to form the microsporocytes. There is an early vacuolation of cells forming the connective. The procambium forms a single amphicribral bundle that traverses the elongating filament. Much variation was observed in microsporogenesis, microspores, and in the mature pollen grains in the irradiated plants as compared with the controls. Externally, the following morphological variations were found in the flowers from early formed cymes of the inflorescences of irradiated plants: dehydrated flower buds, abscission of immature flowers, abscission of one or more anther per flower, pleiomery and meiomery of stamens, and enlarged anthers. Flowers from later occurring cymes on the same inflorescences did not appear aberrant when compared (superficially) with the controls. The reversion to normal growth patterns suggests that these radiation induced abnormalities were non-genetic physiological disturbances. (Diss. Abstr.)

28392 POST-RADIATION RECOVERY OF PLANTS AND ITS MODIFICATION. Grodzinskii, D. M. (Inst. of Plant Physiology, Kiev). Fiziol. Biokhim. Kul't. Rast.; 3: No. 3, 314-23(1971). (In Russian).

The mechanisms involved in the plant cell exposed to nuclear radiation and in the plant cell protected against the harmful effects of radiation were studied. For this purpose, free radical states arising in plant seeds under the effect of gamma radiation were studied by recording EPR spectra under various conditions of irradiation and of preservation in the post-radiation period. Bidzilya studied the recombination processes of free radical states as functions of temperature, humidity, and other factors. It was found that the measured yield curves of free radicals are nonlinear and are characterized by some saturation regions. The EPR spectra changed with increasing radiation dose: the signal becomes asymmetrical and is gradually split. In this way, EPR could be used to study the radicals produced by gamma radiation. Following irradiation of seeds with natural paramagnetism, it was found that the level of paramagnetism was lowered, giving rise to the assumption that the free radicals combine with some of the natural paramagnetic centers. A modifying effect on the gamma-irradiated seeds by ultraviolet rays was found; the uv rays decrease the intensity of the spectrum of gamma-induced free radical states. Several basic mechanisms of plant recovery after irradiation are discussed: the molecular and biosynthetic mechanisms, as well as actual repair by special systems of nonconservative DNA synthesis. At the cellular level, recovery appears to be achieved by elimination of affected cells and acceleration of proliferative activity of unaffected or repaired cells. Recovery can be brought about also by materials modifying the radiation reaction of the plant. One of the most effective agents in connection with this is oxygen: when it is present in the medium, radiation damage to the organism is considerably reduced. Effective protection of plants from radiation is, in the opinion of the author, entirely possible. (JPRS)

28393 GROWTH OF THE BARLEY COLEOPTILE. I. ITS RELATIONSHIP TO CELL NUMBER AND LENGTH IN NORMAL AND γ-IRRADIATED SEEDLINGS. Liptay, A.; Davidson, D. (McMaster Univ., Hamilton, Ont.). Amer. J. Bot.; 59: No. 3, 266-9(Mar 1972).

The number of cells per vertical column in barley coleoptiles differs in various growth classes; it is highest in tall coleoptiles, intermediate in medium ones, and lowest in short ones. In those that elongate early and grow rapidly, cells per column increased from 88 to 218 between 12 and 44 hr after the seeds were placed on water; in short coleoptiles they increased to only 85 per column after 115 hr because elongation and division are restricted in these. Cell number does not increase in coleoptiles from seeds irradiated with 250 krad. Variation in the growth pattern of irradiated coleoptiles was similar to that of normal ones, although the range in lengths was reduced. Although the number of cells is much higher in tall controls than in irradiated coleoptiles, the latter can become tall; therefore an increase in cell number during germination does not seem to be a prerequisite for tallness. Coleoptiles 32 mm long, from irradiated seeds, have the same number of cells per column as the shortest ones (6 mm) after 119 hr. (auth)

28394 EFFECT OF GAMMA RADIATION ON ANTHOCYANIN AND FLAVONOL PIGMENTS IN CRANBERRIES (VACCINIUM MACROCARPON AIT.). Lees, David H.; Francis, F. J. (Univ. of Massachusetts, Amherst). J. Amer. Soc. Hort. Sci.; 97: No. 1, 128-32(1972).

The effectiveness of gamma radiation as an enhancer of anthocyanin and flavonol pigment synthesis in cranberries was determined. Three different maturities of cranberries, based on their degree of coloration, and radiation levels of 150 and 300 krad were employed. The changes in the anthocyanin and flavonol pigments were measured quantitatively at regular intervals during storage. Radiation had a beneficial effect on the pigmentation of full-red cranberries and resulted in a significant increase in the anthocyanin and flavonol pigment contents. Effects on the less colored berries were not as great and in some cases flavonoid synthesis was reduced. The radiation induced changes were strictly quantitative in nature and there were no qualitative changes in the anthocyanins and flavonols. The visual effects of radiation on cranberries were minor softening and a stimulation of pigment production in the endocarp area of the fruit, resulting in internal coloration of the fruit. It was concluded that gamma radiation has an effect on the biosynthesis of the pigments involved and that the maturity stage of the cranberries was the controlling factor in determining the degree of response to radiation treatment. A possible mode of action of radiation on flavonoid synthesis was postulated. (auth)

28395 INDUCTION AND CHARACTERISATION OF CELL WALL MUTANTS OF CHLAMYDOMONAS REINHARDI. Hyams, Jerry; Davies, D. Roy (John Innes Inst., Norwich, Eng.). Mutat. Res.; 14: No. 4, 381-9(Apr 1972).

79 mutants of Chlamydomonas reinhardi exhibiting defective cell wall morphogenesis have been induced using N-methyl-N'-nitro-N-nitrosoguanidine (NNG), uv light and ethyl methanesulphonate (EMS). The kinetics of their induction, and their morphology as revealed by electron microscopy, is described. Genetic analysis of 32 randomly chosen mutants indicates the existence of at least 19 loci concerned with the organization of the cell wall. (auth)

28396 INFLUENCE OF IONIZING RADIATION ON THE STATE OF NITROGEN FORMS IN WHEAT RADICLES. Gamkrelidze, L. M. Soobshch. Akad. Nauk Gruz. SSR; 66: No. 1, 159-60(Apr 1972). (In Russian).

Six-day radicles of durum and soft wheat of the Georgian varieties were irradiated with different doses of x radiation. Irradiated wheat of the soft variety accumulated different nitrogen forms more intensively than did the durum variety, this pointing to the radioresistance of the durum wheat. (auth)

28397 DEPENDENCE OF OXYGEN AFTER-EFFECTS AND CHROMOSOME MUTATION YIELD ON THE PHYSIOLOGICAL CONDITION OF γ IRRADIATED BARLEY SEEDS. Nuzhdin, N. I.; Dozortseva, R. L. (Inst. of Biophysics, Moscow). Izv. Akad. Nauk SSSR, Ser. Biol.; 11: No. 1, 63-76(Jan-Feb 1972). (In Russian).

No oxygen after-effects were observed in the irradiated embryonic cells of barley seeds treated in the G_0 phase. Following transition from G_0 to G_1 in the absence of air, the cells manifested only oxygen-independent damage. Storage of the seeds containing irradiated embryonic cells in the G_1 phase resulted in an increase in the percentage of abnormal cells due to the development of oxygen-independent injuries. There is a lag period during which no oxygen-dependent damage is evident and a relationship between the length of the lag period and the oxygen content in the seed soaking medium was observed. It was suggested that during the course of the lag period the cell accumulates enzymes that help to produce oxygen-dependent damage. (H.L.W.)

28398 BEAN MUTANT INDUCED BY IONIZING RADIATION. VII. COMPACT MUTANT. Moh, C. C.; Alan, J. J. (Inter-American Inst. of Agricultural Sciences, Turrialba, Costa Rica). Contract AT(30-1)-2043. Turrialba; 21: No. 4, 478-80(Oct-Dec 1971). (NYO-2043-239).

Dry seeds from a pure line of Phaseolus vulgaris were irradiated with an acute dose of gamma radiation of 8 kR from a ^{137}Cs source. The dose rate was 952 R per min. The irradiated seeds were immediately planted in the field. When mature, the compact mutant was isolated in the self-progeny test in the F_3 generation. A study was conducted on the inheritance of the compact character by testing the genetic constitution of the progeny of heterozygotes. Results indicated that this character was determined by a simple recessive gene. (H.L.W.)

Radiation Effects on Animals (External Source)

Refer also to abstract 29175.

28399 RADIATION QUANTITIES AND UNITS. Vidmar, M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 69-85 of Radiation Dosimetry. Vol. 1. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

The definitions of radiation quantities and units recommended by the ICRU in 1968 are reviewed. It is recommended that: the rad be used solely for expressions of absorbed dose; the roentgen be used solely for exposure doses, the curie be used solely for expression of activity, and the rem be used for dose equivalent. It is pointed out that, for radiation protection purposes, it is useful to use the term dose equivalent, which is defined as the product of absorbed dose, quality factor, dose distribution factor, and other modifying factors when relevant. Definitions are included for 23 additional terms applicable to radiation dose measurements. (C.H.)

Man

Refer also to abstracts 27735, 28335, 29933, and 29978.

28400 (CONF-710223) BASIC MECHANISMS IN RADIATION BIOLOGY AND MEDICINE. Proceedings of a Symposium held at All India Institute of Medical Sciences, New Delhi, February 11-13, 1971. (Department of Atomic Energy, Bombay (India). Biology and Medical Committee). 1971. 743p.

Separate abstracts were prepared for 45 papers presented at the conference. Fourteen additional papers discuss various aspects of biological research. (H.L.W.)

For abstracts of individual papers see: 28319-28328, 28337-28339, 28349-28352, 28381-28390, 28410, 28456-28463, 28489-28492, 28498, 28512, 28525, 28526, and 29965.

28401 (ORO-3578-9) EFFECTS OF RADIATION ON PERMEABILITY AND ENZYMES OF SKIN. Final Report. Olson, Robert L. (Oklahoma Univ., Oklahoma City. Medical Center). 13 Oct 1971. Contract AT(40-1)-3578. 4p. Dep. NTIS.

Electron microscopic histochemical studies were performed on normal and ultraviolet-injured human skin with and without applications or injections of foreign materials. Results are described for observations on intercellular circulation using injected ferritin, phagocytosis, lysosomes, and melanin. It was found that ultraviolet light caused a dispersion of melanosomes and other lysosomal particles. The dispersion of melanosomes in Negroes and Caucasians is discussed and the effects of ultraviolet-induced skin cancer on the uneven distribution of pigment are described. (H.L.W.)

28402 (SZS-18/71) IS THERE ANY EXPERIMENTAL EVIDENCE FOR THE APPLICATION OF RADIOPROTECTIVE SUBSTANCES IN IRRADIATION THERAPY? Huber, R.; Teichmann, B. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Oct 1971. 35p. (In German). Dep. NTIS (U. S. Sales Only).

Results of animal studies on the radioprotective compounds of the group cysteine-MEA-AET indicate that irradiation therapy of malignant tumors in man should be a hopeful field for the application of radioprotective substances. The experimental basis leading to this opinion is critically examined. (auth)

28403 RADIATION INJURY AND RADIATION PROTECTION. INJURIES CAUSED BY IONIZING RADIATION (WITH SPECIAL REFERENCE TO DELAYED INJURIES). Fischer, H. (Academy of Hygiene and Health of the Federation Defense, Munich). Muenchen. Med. Wochenschr.; 112: 591-5(27 Mar 1970). (In German).

A survey was made of various types of radiation damage to various organs of the human body, and from a wide variety of causes. Work-related skin injury, eye cataracts, and kidney damage are discussed. Considerable attention is given to the history of casualties of the Hiroshima and Nagasaki bomb explosions, with tabulated data on leukemia incidence in adults and children versus distance from the epicenters of the nuclear detonations. Data on the incidence of malformations, aging processes, testicle changes, lung and breast cancer, and mortality from other malignancies are cited. (56 references.) (K.S.W.)

28404 LATE DAMAGE TO THE LUNG TISSUE FOLLOWING RADIOTHERAPY OF MAMMARY CANCER. Guzecki, Andrzej (Inst. of Oncology, Krakow). Pol. Przegl. Radiol. Med. Nukl.; 35: No. 6, 723-30(Nov-Dec 1971). (In Polish).

From the material of 1209 women with mammary cancer treated at the Institute of Oncology in Kraków in a period of 10 yrs, 661 cases treated by irradiation were analyzed in detail. All these cases survived for 12 months, and had full clinical, radiological, and histological documentation. Late radiation damage to the lung tissue manifested itself with appearance of fibrotic changes that in some cases took the appearance of cirrhosis. Radiation injury developed in 23.4% of cases, most frequently in those receiving postoperative radiotherapy. A rise in the incidence of radiation injury was observed in women aged over 61 yrs. (auth)

28405 CHROMOSOME ABERRATIONS IN CULTURES OF PERIPHERAL BLOOD FROM PERSONNEL OF A RADIOTHERAPY DEPARTMENT. Leonard, A.; Deknudt, G.; Linden, G.; Leonard, E. D. (CEN, Mol, Belgium). Rev. Eur. Etud. Clin. Biol.; 16: No. 9, 933-7(Nov 1971).

Eleven radiation workers from a radiotherapy department and six control persons who had never been exposed to any known radiation apart from diagnostic reasons were examined for the presence and number of structural chromosome abnormalities in peripheral leukocytes. The observations confirm that chronic exposure of radiation workers causes an increase in the chromosome aberrations types normally found in the controls (gaps, chromatid breaks, and chromosome fragments) and can induce aberrations that are rarely observed in non-exposed individuals (deletions, translocations, polycentrics, and rings). Since it was possible to establish a correlation between the ratio of abnormal cells and the mean annual dose registered by the personal dosimeters, it is concluded that chromosome analysis of peripheral leukocytes from radiation workers can be used as a biological indicator but not for quantitative biological dosimetry. (France)

28406 CLINICO-PHYSIOLOGICAL CHARACTERISTICS OF VENOUS DISORDERS OF THE CEREBRAL CIRCULATION DURING IRRADIATION. Kirsanova, G. I.; Sosnovskaya, F. M. Med. Radiol.; 17: No. 1, 16-22(Jan 1972). (In Russian).

Eighty-four patients suffering from neurocirculatory dycrasias with signs of insufficiency of cerebral veins following radiotherapy were examined using electroencephalography in a number of func-

tional tests. It was concluded that the relation between the state of venous cerebral circulation and the total dose of irradiation, as well as on the presence of manifestations of impeded venous circulation from the cranial cavity all influence the severity of the radiation syndrome. (auth)

28407 RELATIVE EFFECTS OF FAST NEUTRONS AND X RAYS ON HUMAN TUMORS. Sekiyama, Shigetaka (National Inst. of Radiological Sciences, Chiba, Japan); Tsunemoto, Hiroshi; Inada, Tetsuo; Tazaki, Eisei; Mochizuki, Yukio. Gan No Rinsho; 16: No. 11, 1077-83(Nov 1970). (In Japanese).

In order to compare the effect of fast neutrons and x rays, cases with about the same size of tumor were selected from mammary cancer metastasized to subcutaneous region. These cases were irradiated with either fast neutrons or x rays and the tumor was extirpated on 7th day after irradiation. For fast neutrons, the Van de Graaff accelerator was used and fast neutrons of En = 2.0 MeV obtained from $^{9}Be(d,n)^{10}B$ reaction were employed to give a total dose of 400 rad during three days. The dose of x irradiation was 1000 rad during three days. The scirrhous duct carcinoma from a 72-year-old female showed stronger degeneration after fast neutron irradiation than after x ray irradiation by optical microscope examination. The papillary duct carcinoma from a 76-year-old female showed degeneration of carcinoma cells with proliferation of stromal tissue after x irradiation, while a marked degeneration of carcinoma cells accompanied by marked proliferation and vitrification of the stromal tissue was seen in the case irradiated with fast neutrons. Electron microscopic examination showed the lowering of electron density in the nucleus and cytoplasm after x ray irradiation, with dilatation of the cells. After neutron irradiation, development of organelles in the cells was poor, with high electron density, and the nucleus was concentrated with high electron density, showing an irregular shape, and degeneration of collagenous fiber was also observed. The skin showed high keratinization by x-ray irradiation, with slight degeneration of epidermal cells. This keratinization of the skin was further advanced in the case of fast neutron irradiation, with vacuolization of nucleus. Degeneration of epidermal cells was more advanced after fast neutron irradiation than after the use of x rays. (Japan)

28408 POPULATION DOSE AND MEDICAL X RAY. Busick, D D. (Stanford Linear Accelerator Center, Calif.). Health Phys.; 22: No. 4, 415-16(Apr 1972).

It is argued that clinical judgement for individual patients, rather than precise legal considerations, is desirable in deciding radiation procedures. The following recommendations are made:- (1) A closer relationship between the medical profession and health physicists. (2) Training for x-ray technicians through the Health Physics Society. (3) Cooperation between officers of the respective societies. (UK)

28409 REDUCTION OF PATIENT EXPOSURE FROM DIAGNOSTIC RADIOLOGY BY BODY POSITIONING. Wagner, W.; Buchignani, J. S.; Howley, J. R. (National Inst. of Health, Bethesda, Md.). Health Phys.; 22: No. 4, 398-9(Apr 1972).

Exposures were measured with thermoluminescent dosemeters during a prone and supine series of human phantom measurements in relation to tomography procedures. The midbeam exposure was the same for both series (2900 mrads) and the gonadal exposure was similar. In the prone series, the dose to the eyes was 14 mrads and to the thyroid 100 mrad. In the supine series, the eye lens dose was 30 mrad and that of the thyroid 1890 mrad. The diagnostic quality of both series was the same. (UK)

28410 REVIEW OF RADIATION DOSES IN PEDIATRIC RADIOISOTOPIC INVESTIGATIONS. Sastry, K. G. K.; Reddy, A. R.; Nagaratnam, A. (Inst. of Nuclear Medicine and Allied Sciences, Delhi). pp 701-10 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

A general discussion is presented of the factors to be taken into account when evaluating the radiation doses to specific organs and the whole body during the pediatric uses of radioisotopes. A review of the doses received in specific clinical situations of interest is included. (auth)

28411 LOW DOSE RADIATION CANCERS IN MAN. Stewart, Alice (Oxford Univ.). Advan. Cancer Res.; 14: 359-90(1971).

Data accumulated during the past 20 years from epidemiological surveys on the relation between low dose radiation exposure and the incidence of leukemia and other neoplasms in man are reviewed. Data on three groups of irradiated humans (A-bomb survivors, patients with ankylosing spondylitis treated with radiation therapy, and children exposed in utero to x radiation during diagnostic radiographic studies on the mother) all show that the delayed effects of radiation are dose dependent. Emphasis is placed on the findings of the Oxford Survey in Great Britain, which assembled data on juvenile cancer deaths since 1953 in relation to prenatal radiation doses. The data indicate that: the cancer yield following prenatal irradiation is directly proportional to the dose; the extra cancer risk is the same for solid tumors as for leukemia; the number of cancer deaths that would result if one million children were exposed to one rad of ionizing radiation shortly before birth would be approximately 600; and the immature (first trimester) fetus is much more sensitive to radiation than the older fetus. These findings are discussed in relation to various theories on the reaction mechanisms involved in carcinogenesis. It is concluded that there is need for a working hypothyesis which allows tissue reactions to all pathological processes (including cancer initiations) to be age dependent and that also allows for delayed reactions to radiation damage to be tissue selective in some, but not all, circumstances. It is suggested that cancers are the result of somatic mutations whose effects are of little consequence unless the demand for mitotically competent cells is well above the average. It is postulated that irradiation sooner or later induces a demand for new cells to replace the ones destroyed by the radiations and this may give mutant stem cells a chance to infiltrate the bone marrow and other sources of myelocytes and initiate the carcinogenic process. (52 references.) (C.H.)

28412 RADIATION EFFECT ON THE SKIN. Warren, Shields (New England Deaconess Hospital, Boston). Contract AT(30-1)-3777. pp 261-78 of Skin. /Helwig, Elson B. (ed.). Baltimore; Williams and Wilkins Co. (1971).

Pathological changes in human skin following acute or chronic exposure to ionizing radiations are described. The types of ionizing radiation that produce significant changes in the skin (β particles, primary electrons, γ, and x radiation) are reviewed and their linear energy transfer and shielding characteristics are described. Beta radiation burns and transient epilation in humans exposed to fallout are described. Erythema and edema are the visible signs of acute reaction of the skin to radiation, and these disappear as the reaction recedes. However, there may be a transition from acute to chronic radiation dermatitis, especially following exposure to divided doses above 5000 or 6000 R or single doses above 3000 R. It is pointed out that irradiated skin is easily infected and is very sensitive to sunburn. The pathological features of chronic radiation dermatitis induced in patients following therapy are described. (C.H.)

28413 THEORETICAL AND EXPERIMENTAL DEPTH-DOSE CURVES FOR ELECTRONS IN THE ENERGY RANGE 3 TO 10 MeV. Lillicrap, S. C.; Rosenbloom, M. (Royal Marsden Hospital, Sutton, Eng.). Brit. J. Radiol.; 45: No. 531, 229-30(Mar 1972).

Reference is made to recent communications concerning the shape of the electron beam depth-dose curves in the range 3 to 10 MeV (Orchard and Martin–Smith, Brit. J. Radiol. 44: 817 (1971); Boag, loc. cit. 45: 229 (1972)). The present communication investigates to what extent the fact that clinical electron beams are neither monoenergetic nor unidirectional, having been scattered by a number of surfaces, influences depth-dose distributions, and also how useful theoretical predictions may be for such beams. The authors' experimental data are compared with the theoretical predictions of others. It is evident that the measured distributions are significantly different from the calculated predictions; the peak dose occurs nearer the surface and the dose curve near the surface lies above the predicted distribution. These differences illustrate the combined effect of the energy spectrum of the incident electrons, which appears to be quite broad when entering the patient, and their angular distribution. Calculated predictions based on broad parallel monoenergetic beams may be in considerable error at certain depths. (UK)

28414 PROFESSIONAL EXPOSURE TO IONIZING RADIATION IN THE CSSR IN 1969. Chysky, Jaromir (Inst. of Hygiene and Epidemiology, Prague); Singer, Jan; Trousil, Jaroslav; Hospes, Miroslav. Jad. Energ.; 17: No. 9, 296-307(Sep 1971). (In Czech).

During 1969, personal exposure was measured in 6500 persons engaged in work with ionizing radiation. The results of measurements supplemented by personal data of controlled persons were subject to the hygienic evaluation in 4308 persons exposed to gamma radiation and x rays. Comparison of individual groups of followed up persons was from the point of view of statistical distribution of exposures carried out by means of a variant of the Smirnov–Kolmogorov test. The average exposures were very low in the year 1969. Significantly higher exposures were found in industry, especially at defectoscopy workplaces. In public health establishments, higher exposures were found in workers handling radium. Classification of controlled persons according to the

height of annual exposure and sex, degree of qualification, age groups, duration of work with radiation sources, size of the workplaces, and type of work disclosed some further groups with higher exposures. Monthly exposures exceeding 400 mR were subject to a separate evaluation. Their frequency in individual groups of workers was estimated and their cause evaluated. (auth)

28415 FUNCTION DISORDERS IN THE ORAL CAVITY AS A SIDE EFFECT OF RADIOTHERAPY. Hansen, D.; Meyer, E.; Werner, H. (Univ., Kiel). Z. Laryngol., Rhinol., Otol.; 49: 534-41(Aug 1970). (In German).

Eighty patients treated for malignant disease of the head and neck with telecobalt γ irradiation were examined for various functional disturbances. Simultaneously with the local radiation reaction in the oro-pharynx various changes occurred, such as dryness of the mouth, accumulations of mucous phlegm, loss of appetite, and swallowing difficulties. These were often accompanied by physical and psychological upsets. There were objective signs to account for these subjective symptoms that followed the local radiation reaction in the mouth and throat. Trials of therapeutic measures are reported. (auth)

28416 BIOELECTRIC ACTIVITY OF THE BRAIN UNDER CHRONIC EXPOSURE TO IONIZING RADIATION. Sosnovskaya, F. M. Zh. Nevropatol. Psikhiat.; 71: 205-9(1971). (In Russian).

The results of an EEG study of 78 individuals subjected to the action of small doses of radiation in the range of 10 to 400 R, from a period of 5 to 20 years with the diagnosis of neurocirculatory dystonia are summarized. The achieved results indicate an absence of marked disorders in the bioelectrical brain activity in the majority of the examined people. Those deviations which were detected were characterized by a weakening of the α-rhythm and definite increase of the slow activity with a different intensivity. In some cases there was a tendency to a shift of the "spontaneous" EEG frequencies to more rapid fluctuations. As a whole, there is a tendency to an increase of the EEG changes depending upon the total doses of radiation and the existence of clinical symptoms of radiation sickness. (auth)

28417 RADIATION DOSES DURING TOMOGRAPHY OF VARIOUS PARTS OF THE HEAD. Hollender, Lars; Lysell, Gunnar (Univ. of Lund, Sweden). Odontol. Revy; 22: No. 3, 291-5(1971).

Tomography is increasingly used in oral roentgendiagnosis. Consequently, the radiation doses increase to various parts of the head and neck. This fact justifies the present assessment of the absorbed dose to organs of interest within the head and neck, viz. the eye, the hypophysis, the thyroid, and the submandibular lymph nodes during tomography of the temporomandibular joint. The absorbed dose to the eye was considerable which means that indications for the other tomographic examinations studied here should be restricted. The absorbed dose to the other regions can be considered relatively small. (auth) (Sweden)

28418 RADIATION DOSE OF MEDICAL STAFF IN BULGARIA FOR THE PERIOD 1967–1968 AND SOME ASPECTS OF THE FILM-DOSIMETRIC CONTROL. Vasilev, G. Rentgenol. Radiol.; 9: No. 2, 92-6(1970). (In Bulgarian).

Since 1965, Bulgaria officially applies the Rational Security Standards common to all countries members of the Mutual Economical Assistance Council and based on standards of the International Committee of Radiation Protection. Mass individual dosimetry is promoted by the Central Laboratory at the Research Institute of Radiology and Radiation Hygiene. A total of 2500 persons are under control (90% of them health workers) using the system of film dosimetric control. The doses are determined by the filter analysis method of Prof. Wachsmann. The results are checked every month and reported if the doses exceed by 5% the maximal admissible ones. In 1967 and 1968 more than 90% of the controlled medical workers received less than $^1/_{10}$ of the maximal admissible doses. Only 0.6% (in 1967) and 1.6% (in 1968) received doses exceeding the maximal admissible dose for a year (5 R). In comparison with other countries where conditions are similar to those in Bulgaria (Belgium, GDR, Poland, Sweden), the values and distribution of doses received by the medical personnel appeared to be almost identical. (INIS)

28419 MULTIPLE SQUAMOUS EPITHELIUM CARCINOMAS AFTER UNCONTROLLED USE OF RADIUM COMPRESS. Tempel, V.; Mehler, E.; Berndt, G. (Bezirkskrankenhauses, Dresden). Dermatol. Monatsschr.; 156: No. 2, 115-19(1970). (In German).

A report is presented on a female (81 years old), who, after applying a radium cushion in the area of the os sacrum during a prolonged period, developed radiogenic praecancerous changes of the tegument. Some of these symptoms were degenerated into pavement epithelium carcinomas. This finding confirms the well-known fact, that the application of such compresses needs careful control. In the present time these compresses are still traded by medically unlearned persons, therefore they should be ordered only by a medical staff. (auth)

28420 INTESTINAL FISTULA AFTER PELVIC IRRADIATION AND RADICAL SURGERY. Casey, M. J.; Beattie, E. J.; Clark, D. G. C.; (and others) (Memorial Hospital for Cancer and Allied Diseases, New York). Postgrad. Med.; 50: No. 1, 168-71(Jul 1971).

A 34 yr old woman was treated by radium application (2900 mgh) and ^{60}Co teletherapy (5000 rads) directed to the pelvis for a stage I epidermal carcinoma, in situ, of the cervix, with glandular involvement. Her subsequent case history is discussed including surgical treatment of the radiation necrosis. (auth)

28421 SURFACE IONISATION RATIOS FOR ELECTRONS IN THE ENERGY RANGE 3 TO 11 MeV. Boag, J. W. (Inst. of Cancer Research, Sutton, Eng.). Brit. J. Radiol.; 45: No. 531, 229(Mar 1972).

Some comments are offered on the communication by Orchard and Martin–Smith (Brit. J. Radiol. 44: 817 (1971)), which drew attention to some matters concerning the use of electron beams that must be fully understood when such beams are used clinically. One such matter is a peak in depth-dose curves observed in the range 3 to 10 MeV. The peak-to-surface ratio for 4 MeV electrons in polystyrene is calculated to be 1.48, whilst that for 10 MeV electrons is 1.32. A simple qualitative explanation for this effect is given in the present communication. End-on irradiation effects are also discussed; these can have practical consequences as, for instance, in the sterilization of plastic syringes by an electron beam. Enough scattering material must be packed around such articles to ensure that the thin webs on the barrel are not irradiated solely edge-on, otherwise they may shield the parts lying at the base of the web. These scattering effects are too complex to be handled mathematically in any convenient way for an inhomogeneous object, and this is one reason why transfer of information obtained on a uniform phantom to an inhomogeneous patient cannot be done very accurately; the estimation of detailed dose distributions within a patient is more difficult and less accurate for electron radiation than for x-rays. (UK)

28422 NEUTRON DEPTH DOSE DISTRIBUTIONS IN HETEROGENEOUS PHANTOMS. Poston, John Ware. Atlanta; Georgia Inst. of Tech. (1971). 140p. University Microfilms Order No. 71-28,104.

Thesis.

In the past few years, there has been an increasing interest in neutron radiography for both industrial and medical applications. Such use in radiography as well as potential application of neutrons in cancer therapy drew attention to the need for further research to establish reliable data on neutron dosimetry in such cases. These investigations were directed toward the measurement of dose distributions in various media, including the human body, beam collimation studies, and development of means of imaging both fast and thermal neutrons. The study reported here was begun with the purpose of establishing neutron dose distributions at bone-tissue interfaces in the human body. Similar measurements performed for photons of up to 200 keV have shown a reduction in the dose delivered to tissue areas shielded by bone of up to a factor of two. The design and operational characteristics of detectors intended to measure analogous distributions due to fast neutrons are described. Measured distributions due to fission spectrum and 14-MeV neutrons are presented and discussed. Results from measurements with fission spectrum neutrons indicate that the high voltage electrodes attached to the front of the detectors were too thick to allow the measurement of the changes in dose distributions very near the interface. However, distributions due to 14-MeV neutrons indicate a reduction in the predicted homogeneous depth dose distribution due to the presence of bone. The reduction is about 20% at a distance in bone of about 2 cm. In tissue at the rear of bone, a buildup or increase in the dose deposited was demonstrated that is about 50% more than the interface value at a depth in tissue of 0.8 to 1.0 cm. These results are discussed and compared with available theoretical descriptions. Also included in the discussion are the problems associated with the use of these detectors, a discussion of the sources of error in the experiment, and a set of recommendations for improvement and further study in this area. (Diss. Abstr. Int., B)

28423 RADIATION EXPOSURE IN BRONCHOGRAPHY IN CHILDHOOD UNDER THE CONDITIONS OF A PICTURE-AMPLIFYING DEVICE. Stier, M.; Wiesner, B.; Angerstein, W. (Forschungsinstitut fuer Tuberkulose und Lungenkrankheiten,

Berlin). Z. Erkr. Atmungsorgane Folia Bronchol.; 133: 379-83 (Dec 1970). (In German).

During bronchography, the radiation dose rate was measured in the gonadal region, the entrance area at the back of the thorax, and the exit area at the front of the thorax. With 50 to 60 kV x rays and an image amplifier, the following values were obtained: for children, gonadal dose of 245 μR, entrance dose of 2.95 R, and exit dose of 37 mR; for adults, gonadal dose 322 μR, entrance dose 3.6 R, and exit dose 45 mR. Mean examination time was 44 sec. Results showed that bronchography with image amplifier in children represents a harmless procedure with negligible somatic and genetic effects. These findings, however, were obtained only with sharp collimation of the beam and gonadal protection by lead rubber sheets. Without these precautionary measures, gonadal doses were higher by a factor of 1,000. (H.B.G.)

28424 RADIATION AVERAGE DOSE ABSORBED BY TRUCK DRIVERS IN ITALY (1967-1968). Faloci, C.; Susanna, A. (CNEN, Rome). Minerva Fisiconucl.; 14: No. 4, 159-71(1970). (In Italian). (RT/PROT-(70)7bis).

A study was conducted to estimate the average dose absorbed by truck drivers during 1967-1968. In the course of the study, a statistical survey was also made on the shipments of radioactive materials that took place in Italy during this period, determining the distribution frequency on the radionuclides most commonly used for therapeutical, diagnostic, industrial, and research purposes. In conducting the survey, constant attention was given to the objective of identifying the protection problems connected with the shipping activities. (auth)

28425 RADIOBIOLOGICAL CONSIDERATIONS FOR PIONS IN RADIOTHERAPY. Feola, J.; Maruyama, Y. (Univ. of Minnesota, Minneapolis. Univ. of Kentucky, Lexington). Oncology; 25: No. 6, 536-57(1971).

A new radiation beam, the π^- meson beam, is being considered for radiotherapy of human neoplasms. It is clear that this beam has special attributes that make it useful in certain types of neoplasms. However, human experience is heavily based upon low LET beams, alterations of dose rate, and treatment planning to confine dose to required therapeutic volumes. The use of this new beam must be considered upon existing knowledge regarding the natural history of the neoplasms, and the expected biological properties of the pion beam. It is likely that revision of present fractionation schedules will be required but most likely the pions will be useful to treat the residual tumor core of a tumor reduced in size by prior external beam, low LET therapy. (auth)

28426 RADIATION DOSIMETRY. VOL. 1. Proceedings of the International Summer School on Radiation Protection, Cavtat, Yugoslavia, September 21-30, 1970. Miric, I. (ed.). Belgrade; Boris Kidric Institute of Nuclear Sciences (1971). 367p. (CONF-700939-(Vol.1)).

Separate abstracts were prepared on 17 papers presented at this conference on radiation dosimetry. (C.H.)

For abstracts of individual papers see: 28362, 28399, 28427-28435, 28479, 28500, 28501, 28505, 28518, and 28519.

28427 MAXIMUM PERMISSIBLE LEVELS OF EXPOSURE TO IONIZING RADIATION. Morgan, Karl Z. (Oak Ridge National Lab., Tenn.). pp 7-68 of Radiation Dosimetry. Vol. 1. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

Criteria used for establishing standards for maximum permissible radiation exposure for the general human population and for occupational exposure of personnel are discussed. Changes in maximum permissible values for occupational exposure from 1925 to 1970 are reviewed and data used as the basis for present maximum permissible exposure values are summarized. It is pointed out that the principal source of radiation exposure of the general population in developed countries is diagnostic medical procedures. Problems in establishing standards for the radiation exposure of the general population resulting from the release of radioisotopes to the environment are discussed. It is suggested that the most realistic approach to the development of standards would be based on the determination of critical radioisotopes, critical population groups, and critical environmental factors that influence the radiation dose and dose rate, rather than standards based on maximum permissible concentrations of radioisotopes in the atmosphere. (C.H.)

28428 DEPTH DOSE IN AN ANTHROPOMORPHIC PHANTOM FOR NEUTRON BEAMS OF ENERGIES UP TO 15 MeV. Snyder, Walter S. (Oak Ridge National Lab., Tenn.). pp 160-84 of Radiation Dosimetry. Vol. 1. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

A homogeneous tissue-equivalent cylindrical human phantom was employed for measurements of the radiation dose at various depths during exposure to neutron beams of energies up to 15 MeV. To simplify calculations, the tissue was assumed to contain only carbon, hydrogen, nitrogen, and oxygen, and the neutron beam was broad enough to cover the entire area presented by the lateral area of the phantom. Computer calculations were employed that took into account the physical interactions and energy losses in various subdivisions of the phantom. (C.H.)

28429 CALCULATIONS OF DEPTH DOSE CURVES FROM NEUTRONS AND PROTONS OF HIGH ENERGY AND THEIR INTERPRETATION FOR RADIATION PROTECTION. Snyder, Walter S.; Wright, H. A.; Turner, J. E.; Neufeld, Jacob (Oak Ridge National Lab., Tenn.). pp 185-98 of Radiation Dosimetry. Vol. 1. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

Computer calculations applicable to depth dose measurements of high energy neutrons and protons in man are presented. Comparison of the calculated data with data from measurements in tissue equivalent phantoms showed fair agreement. Applications of the calculated data for estimations of the radiation dose to man in the event of exposure are discussed. (C.H.)

28430 PRACTICAL ATTITUDE OF THE PHYSICIAN IN CASE OF ACCIDENTAL OVEREXPOSURE. Le Go, R. (CEN, Fontenay-aux-Roses, France). pp 231-46 of Radiation Dosimetry. Vol. 1. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

Methods for handling a case of accidental radiation overexposure are summarized. A flow chart describing the most useful steps in relation to information available as to the radiation dose received is presented. Important actions which should not be neglected include: take blood and urine samples immediately; check the individual dosimetric readings; preserve hair and nails samples for beta counting; and, in the case of neutron exposure, make a gross measurement of induced activity in the whole body by means of the instrumentation equipment available. (auth)

28431 CHROMOSOME ABERRATION ANALYSIS AS A BIOLOGICAL DOSEMETER. Dolphin, G. W. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 245-60 of Radiation Dosimetry. Vol. 1. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

The use of chromosome aberration in lymphocytes of human peripheral blood, observed following cell culture, for biological dosimetry is only at the beginning of its development stage, but undoubtedly has considerable potential. More experimental work is needed to iron out the difficulties in the calibration curve. The aberration yields must be ascertained for more types of radiation. The dose rate effect will obviously require more experimental work to establish its magnitude, and the critical dose rate at which the yield changes most rapidly. Nevertheless, this form of dosimetry is the most promising of all the biological dosimetry methods so far tried. In the near future it should be possible to develop aberration analysis of chromosomes of hair root cells, which can now be successfully prepared for microscope examination. This development should enable surface radiation doses to be measured on many parts of the body, which would be useful in the event of a non-uniform irradiation accident. (auth)

28432 ASSESSMENT OF POTENTIATED RADIOBIOLOGICAL EFFECT RESULTING FROM NON-SPECIFIC SIMULTANEOUS HARMFUL AGENTS. Radotic, M. M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 247-62 of Radiation Dosimetry. Vol. 1. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

While practicing routine radiation protection, particular attention has to be paid to all environmental agents capable of increasing the incidence of observable radiation injuries. It is pointed out that there are some difficulties in the assessment of the potentiating effects of other environmental agents. Some of the possible ways to visualize and quantitate them are presented. (auth)

28433 DOSIMETRY IN MAN. Le Go, R. (CEN, Fontenay-aux-Roses, France). pp 261-76 of Radiation Dosimetry. Vol. 1. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

Methods for estimating the radiation dose to man following accidental exposure are reviewed. The reliability of radiation dose estimates based on observations of several biological and physiological parameters is discussed. It is pointed out that quantitative relations can be established between radiation dose and the number of chromosome aberrations in cultured lymphocytes when peripheral blood samples are taken within a few hours following exposure. The severe drop in the proliferation rate of bone marrow cells, tested by the mitotic index, should be a good test of radiation exposure dose. However, the response amplitude of this biological system quickly reaches saturation and above a certain dose level the bone marrow will appear quite depopulated, so quantitative data cannot be derived from the mitotic index. Amino acid urinary excretion rate is another proposed index of radiation dose, but it is not reliable because of the many steps of intermediary metabolism that must occur between the initial tissue injury and urinary excretion of the metabolite. The reliability of radiation doses recorded by various types of personal dosimeters is considered. It is pointed out that the radiation dose recorded by the dosimeter is a measure of the radiation incident on the dosimeter and not necessarily that incident on the individual wearing the dosimeter. If the person is facing the radiation source the dosimeter and the skin surface around it will receive comparable, but not identical, radiation doses, but if the individual is facing another direction there will be a greater discrepancy between the reading on the dosimeter and the dose received by the individual. The indicative meaning of the dosimeter can also be restricted when complex radiation beams are involved, since each element of the dosimeter records only a certain part of the spectrum. Because of these limitations, the readings of dosimeters are not sufficient to characterize the degree of radiation exposure, especially when the whole body is involved. The use of tissue-equivalent human phantoms, bearing a dosimeter like the one worn by the accidentally exposed individual, to reconstruct the accident and record the radiation dose on a number of dosimeters located in various anatomical areas to estimate radiation doses to various body areas is described. The use of various phantom types for this purpose is discussed. Use of the data to estimate the integral doses to bone marrow and survival chances are described. (C.H.)

28434 HAEMATOLOGICAL DOSIMETER. Le Go, R. (CEN, Fontenay-aux-Roses, France). pp 277-97 of Radiation Dosimetry. Vol. 1. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

Following irradiation over a wide range of doses, bone marrow is the critical organ for man. The survival or nonsurvival of an irradiated individual will mainly depend on the evolution of the three blood cell lines originating in the bone marrow, the erythrocytes, granulocytic leukocytes, and platelets. An analytical review of the different blood cell evolution curves and the effects of various radiation dose curves is presented. It is concluded that, while these curves are interesting, both as to their slopes and the minimum value reached, unfortunately these two characteristics appear at a relatively late period following exposure. The real peak of the granulocytes cannot be accurately known unless a large number of flow samples were taken during the first 48 days following exposure. There is no general agreement on the value of the lymphocyte drop beyond a certain radiation dose level. However, even if one single evolution curve cannot be considered as a dosimeter, as a whole their agreement represents a set of data that allows an assessment of the radiation dose received in an individual case of exposure within a given range. (auth)

28435 CHROMOSOME AS A DOSIMETER. Le Go, R. (CEN, Fontenay-aux-Roses, France). pp 298-315 of Radiation Dosimetry. Vol. 1. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

Criteria for the use of chromosome aberrations observed in cultured lymphocytes from human peripheral blood samples as biological radiation dosimeters are reviewed. The advantages and limitations of this biological dosimeter are discussed in detail. (C.H.)

28436 RADIATION-INDUCED HUMAN CHROMOSOME ABERRATION YIELDS FOLLOWING AN ACCIDENTAL WHOLE-BODY EXPOSURE TO ^{60}Co γ-RAYS. Brewen, J. G.; Preston, R. J.; Littlefield, L. G. (Oak Ridge National Lab., Tenn. Oak Ridge Associated Universities, Tenn.). Radiat. Res.; 49: No. 3, 647-56(Mar 1972).

Chromosome aberration yields were obtained from short-term peripheral leukocyte cultures established at various times after an accidental whole-body exposure to ^{60}Co γ rays. The yield of centric rings plus dicentrics did not vary significantly over the first 32 days after exposure. The mean yield for this sampling period was 0.228 ± 0.010 centric rings plus dicentrics per cell. Based on the coefficients of aberration production obtained from an acute γ-ray dose-response study on cells in vitro, this yield corresponds to an average midline dose of 144 R. This biological estimate is in excellent agreement with the physically derived estimate of 127 R that was obtained by irradiating an Alderson Rando phantom containing LiF thermoluminescent dosimeters under conditions as similar as possible to those of the patient's exposure. (auth)

Vertebrates

Refer also to abstracts 28321 and 28362.

28437 (AD-732391) MEASUREMENT OF CAPILLARY PERMEABILITY CHANGES IN THE IRRADIATED RAT USING A DOUBLE ISOTOPE TECHNIQUE. Graham, M. M. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Sep 1971. 22p. (AFRRI-SR-71-12). NTIS.

Capillary permeability was measured using ^{131}I-albumin and ^{125}I-albumin to assay the movement of albumin out of the bloodstream into the interstitial fluid of small intestine and muscle of the irradiated rat. One hr after 800 rads 30 MeV electron whole-body irradiation, small intestine capillary permeability increased significantly, returned to normal levels in a few hrs, and then after 8 hrs increased and remained at 65% above control levels for several days. Muscle capillary permeability increased within 2 hrs after irradiation and remained elevated for several days. Cyproheptadine, an antiserotonin-antihistamine, completely blocked a 45% increase in small intestine capillary permeability seen immediately after 10,000 rads ^{60}Co irradiation but had little effect at 48 hrs after irradiation. (auth) (NTIS)

28438 (AD-732392) GRANULOCYTIC RECOVERY IN THE POLYCYTHEMIC DOG TREATED WITH ENDOTOXIN POST IRRADIATION. Pratt, A. G.; Emerson, R. J.; Baum, S. J. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Sep 1971. 23p. (AFRRI-SR-71-13). NTIS.

The experiment was designed to test the hypothesis that, in hypertransfused dogs with suppressed erythropoiesis, endotoxin-induced increased myelopoietic stimulation 24 hrs after irradiation would enhance leukocytic recovery. The treatment combination of transfusion polycythemia and endotoxin was compared to a control group receiving no therapy or to the results obtained from groups of dogs receiving each treatment alone. The radiation exposure was 150 rads of whole-body x rays. An accentuated abortive rise in the group receiving the combined treatment, accelerated recovery in both groups receiving endotoxin, and impaired leukocytic recovery in the polycythemic animals were observed. Accentuated depression of platelets and splenic enlargement inversely correlated with the platelet levels were observed in the animals receiving transfusion therapy regardless of whether they received endotoxin. It is felt that the data support the concept of interdependence between the various cell lines of hematopoiesis in an experimental model not previously described. (auth) (NTIS)

28439 (AEC-tr-7269) RADIOBIOLOGY. Translation of Radiobiologiya, 11: No. 2, 163-320(1971). 251p. Dep. NTIS.

Author abstracts of the 34 papers in this issue were translated previously and appeared in NSA volume 25: issue 19 as abstract numbers 44761-2; 44776; 44816; 44836-9; 44887; 44935-47; 44970-6; 44982-5; and 45532. (E.R.B.)

28440 (BLG-460, pp 3,27-48) RADIOBIOLOGY. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 1970. 22p.

In Annual scientific report, 1970.

AET — toxicity in x irradiated rats
ALGAE — Acetabularia sp., radiation effects on development, biochemistry, and morphology of, γ
ALGINIC ACID — effects on metabolism of alkaline earth metals in mammals
ALKALINE EARTH METALS — metabolism in mammals, effects of alginates on
BELGIUM — radioisotope content of milk samples collected during 1964 through 1969 in, geographical variations in cesium-137 and strontium-90
BONE MARROW — radiation effects on growth of transplants of irradiated and normal, in mice

CATTLE—tritium uptake by, from drinking water and forage, relation to content of milk
—ruthenium-106 uptake by, from contaminated grass
CELLS—radioinduced changes in ultrastructure of, in lungs of mice, supralethal x
CELLS, CULTURED—radiation effects on synthesis of DNA in mitochondria and nuclei of mammalian, tracer study on x
CHROMOSOMES—radioinduced aberrations of, in peripheral blood cells of medical personnel, following chronic low dose exposure
COBALT-60—uptake by aquatic plants
ECOSYSTEMS—tritium transport kinetics in grassland, following deposition in water
FOOD CHAINS—tritium transport through soil-grass-cattle-milk-man
GAMMA RADIATION—effects on algae, effects on development, biochemistry, and morphology of Acetabularia
IMMUNE REACTIONS—radiation effects on, to injected antigen in mice, x
LIVER—radioinduced changes in ribosomes in, of rats, x
LUNGS—radiation effects on ultrastructure of cells of, in mice, supralethal x
MAMMALIA—metabolism of alkaline earth metals in, effects of alginates on
MANGANESE-54—uptake by aquatic plants
MEDICAL PERSONNEL—radioinduced aberrations of chromosomes in peripheral blood cells of, following chronic low dose exposure
MICE—radioinduced mutations in, x
—radiation effects on growth of transplants of irradiated or normal bone marrow in
—radioinduced sterility in male, protective effects of mixtures of radioprotective compounds against
—radioinduced neoplasms in, protective effects of mixtures of radioprotective compounds against
—radioinduced changes in ultrastructure of lung cells in, following exposure of thorax, supralethal x
—radiation effects on immune reactions in, following antigen injection, x
MILK—tritium content of, following uptake by cattle from drinking water or forage
—radioisotope content of, in Belgium during 1964 through 1969, geographical variations in cesium-137 and strontium-90
NUCLEIC ACID, DEOXYRIBO-,—radiation effects on synthesis of, in mitochondria and nuclei of cultured mammalian cells, tracer study on x
—preparation of tritium-labeled, in bacteria for use as exogenous tracer in studies in biological systems
PLANTS—radioisotope uptake by aquatic, cobalt-60 and manganese-54
PROTEINS—radiation effects on metabolism of, in rats, x
RADIATION—effects on growth of transplants of irradiated and normal bone marrow in mice
RADIOPROTECTIVE COMPOUNDS—effectiveness of mixtures of, for protection of male mice against radioinduced sterility
—effectiveness of mixtures of, for protection of mice against x radioinduced neoplasms
RATS—radioinduced mutations in, x
—radiation effects on survival of, effects of AET on x
—radiation effects on protein metabolism in, x
—radioinduced changes in ribosomes in liver of, x
RIBOSOMES—radioinduced changes in liver, in rats, reaction mechanisms for x
RUTHENIUM-106—uptake by cattle from contaminated grass
TRITIUM—incorporation in DNA in bacteria, for use as exogenous tracer in biological systems
—transport kinetics in grassland ecosystem following deposition in water, effects of season on
X RADIATION—effects on mice, mutagenic
—effects on rats, mutagenic
—effects on survival of rats, effects of AET on
—effects on mice, protective effects of mixtures of radioprotective compounds against neoplastic
—effects on ultrastructure of cells in lungs of mice, supralethal dose
—effects on immune reactions to injected antigen in mice
—effects on metabolism of proteins in rats
—effects on synthesis of DNA in cultured mammalian cells, tracer study on
—effects on ribosomes in liver of rats, biochemical (D.D.D.)

28441 EFFECT OF SODIUM–COPPER CHLOROPHYLLIN ON THE CATHEPTIC ACTIVITY AND GRANULOCYTE INFLITRATION IN UV IRRADIATED RABBIT SKIN. Schischke, B.; Frimmer, M. (Justus-Liebig-Univ., Giessen, Ger.). Strahlentherapie; 142: No. 5, 605-8(Nov 1971). (In German).

UV irradiation of rabbit skin triggers water uptake and granulocyte infiltration in the damaged areas. The increase of proteolytic activity in the irradiated areas is due to invasion of granulocytes. Cu-Chlorophyllin diminishes the enzyme activity of the damaged skin areas as well as inhibiting the granulocyte infiltration. (auth)

28442 EFFECTS OF FRACTIONATED IRRADIATION ON THE PHAGOCYTIC CAPABILITY OF BONE MARROW RETICULAR CELLS IN RATS. Antonijevic, Milos; Dragic, Marko; Hajdukovic, Srdjan (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Strahlentherapie; 142: No. 5, 594-600(Nov 1971).

The phagocytic capability of bone marrow reticular cells was studied in rats in the course of fractionated γ irradiation with 3×200 R spaced at 10-day intervals and with 3×236 R spaced at 4-day intervals. In addition, the effect of single doses of 600 R and 708 R and the same accumulated doses (3×200 R and 3×236 R, respectively) on the phagocytic ability of reticular cells was compared. Carbon method was used for testing the phagocytic function. It was found that fractionated irradiation induced enhanced phagocytic capability of reticular cells during the entire observation period. A comparison of a dose of 600 R and 708 R, respectively, given singly or divided into three fractions did not reveal significant distinction in the pattern of reticular cells, because in all the cases the phagocytic activity was stimulated, although the number of phagocytizing reticular cells was somewhat greater in rats having received accumulated doses, especially in the later observation period (10 days). Conversely, in single dose-irradiated animals the maximum phagocytic response was found to be in the first postirradiation days. (auth)

28443 EFFECTS OF SINGLE AND INTERMITTENT EXPOSURE OF THE WHOLE BODY ON THE LEUCOCYTE COUNT; VOLUME DISTRIBUTION, AND CYTOKINETIC STATE IN THE CIRCULATING BLOOD (EXPERIMENTAL INVESTIGATIONS ON THE RAT). Chone, B.; Glettler, G. (Univ., Heidelberg). Strahlentherapie; 142: No. 5, 575-85(Nov 1971). (In German).

In the circulating blood of the rat, under condition of single or intermittent radiation exposure of the whole body in sublethal range, investigations were performed with regard to the reaction of leucocyte count, proliferation kinetics, and distribution of cell volume. The results obtained were as follows: Following a single exposure of the whole body with 100 to 700 R, a dose-dependent decrease of cells can be observed, in an appropriate relation to time and with a characteristic change in the curve of cell-volume distributions of the leucocytes. This curve generally shows one or two cell peaks that can be projected to corresponding types of cells in the peripheral blood. According to the preponderance of lymphocyte population in the rat, this cell peak is most conpicuous in the initial state. After radiation exposure, the curve of the peak in the range of the granulocytes is elevated; additionally, in connection with the following cell regeneration, shifting takes place in the distribution of cell volume. According to the differentiation of the blood count, this shifting can be related to certain types of cells. Beside the radiation-induced changes of the relation in the initial peaks of cell volume, a further peak was found on electronic measuring level that can be coordinated to an atypically large cell population. Similar results were obtained by fractionated radiation of the whole body with four times 100 or four times 300 R; in the course of this experiment, though, only limited test controls were possible, by reason of the cumulative radiation effect. In comparative tests, after in vivo-incubation with ^{3}H-thymidine (2 μCi/g body weight), the cytokinetic reaction of the peripheral blood cells was examined and evaluated under qualitative and quantitative aspects by means of autoradiography. By the aid of this comparative value, the cytodynamic reactions in the circulating blood could be differentiated and confronted with the following radiation exposure. The results obtained in the various fields are statistically verified; consequently, they build a real comparative relation between blood morphology and proliferation dynamics of the hematopoietic system. (auth)

28444 EARLY MORPHOLOGICAL CHANGES IN THE EPITHELIUM OF THE RAT TONGUE DUE TO DIFFERENT CONDITIONS OF EXPOSURE TO ROENTGEN RADIATION. Ketlinski, S. A. (Inst. of Experimental Medicine, Leningrad). Arkh. Anat., Gistol. Embriol.; 62: No. 2, 33-8(Feb 1972). (In Russian).

Changes in the epithelium of the tongue were studied in mature male rats after the exposure to 800 R of x radiation. The animals were divided into three groups: total irradiation, irradiation of the body (the head screened) and irradiation of the head (screening the other parts of the body). The animals were sacrificed within 2, 6, 12, 26, 50, and 75 hrs after the exposure. Circadian rhythms

of the the mitotic activity in the epithelium of the tongue were taken into account in the control. The mechanism of the mediated effect of radiation was studied in adrenalectomized animals exposed to irradiation of the trunk. Special attention was given to changes in the number of mitotically dividing cells and cells with two nuclei. Inhibition of cell mitotic activity in the epithelium of the tongue took place in every group of irradiation, however the result of mediated effect of irradiation being less. In the animals of the second group, statistically reliable increase of the amount of double-nuclei cells was observed within 12 to 50 hrs after the exposure to radiation. The experiments in adrenalectomized animals clearly showed that the main role in the mediated effect of radiation was played by the hormones of the adrenal cortex. (auth)

28445 MECHANISM OF RADIATION INJURY OF MEGAKARYOCYTES. Baluda, V. P.; Rudakov, I. A.; Tsygankova, V. A.; Maslennikova, R. L.; Rudakova, S. F. (Inst. of Medical Radiology, Obninsk, USSR). Stud. Biophys.; 27: No. 3, 175-82(1971). (In Russian).

Megakaryocytopoiesis was investigated in CBA mice subjected to γ irradiation in doses of 400, 600, and 800 R. From the first day after radiation exposure, megakaryoblast and promegakaryocyte content decreased progressively. The appearance of a large number of megakaryocytes with picnosis of the nucleus and vacuolization of the cytoplasma was noted. These results indicated a decreased influx of cells into the recognizable megakaryocyte population. (auth)

28446 STUDIES ON BONE TISSUE REGENERATION IN RATS AFTER TREATMENT WITH SMALL DOSES OF ^{89}Sr PRIOR TO AND AFTER DECORPORATION. Slvchev, S.; Krastanov, D. Nauch. Tr. Vissh. Med. Inst., Sofia; 49: 1-10(1970).

In a quantitative respect the bone regeneratory processes in all groups of rats do not undergo any essential deviations from the normal. This holds true both of the early and the late regeneration terms. As regards the processes of differentiation and maturation of the regenerate, the pattern differs depending on whether decorporation was applied or not. Certain deviations in callus maturation manifested by atypism and a greater abundance of cells are recorded in both groups of ^{89}Sr-treated animals, but mainly in non-decorporated ones. Small doses of ^{89}Sr exerted a stimulating effect on regenerate in a quantitative respect but created some difficulties in the process of cellular and tissue differentiation. (auth)

28447 SIGNIFICANCE OF THE DELAYED VASCULAR RESPONSE INDUCED BY X-RAY IRRADIATION. Hirabayashi, Koji; Sato, Katsumi (Okayama Univ., Japan). Sanka To Fujinka; 38: No. 6, 805-8(Jun 1971). (In Japanese).

Setting a radiation field of 2 × 3 cm in the abdominal skin of mouse, single irradiation of 1,000 R was performed. The radiation conditions were 250 KVP 30 mA, x ray, F.S.D. 30 cm, Filter 0.25 CU, and the IAI dose rate 466 R/min. in all cases. On the 10th day after irradiation, i.e., when the local vascular response (enlargement and increased permeability) almost reaches a maximum, various anti-vascular response drugs were administered to examine to what extent vascular response was inhibited, using intravenous ^{131}I-RISA method. It was elucidated that the delayed vascular response was most strongly inhibited by mepyramine maleate and hydrocortisone, antihistaminics. This seems to indicate a close association of the delayed response with tissue recovery in the irradiated tissues. It was inferred that mast cells were deeply associated with radiation damage and tissue recovery. (Japan)

28448 EXPERIMENTAL STUDY ON THE RELATION BETWEEN THE SCINTIGRAM OF THE IRRADIATED LIVER USING ^{198}Au-COLLOID AND CHANGES IN UPTAKE OF RETICULOENDOTHELIAL CELLS. Nomura, Setsuo (Hiroshima Univ.). Hiroshima J. Med. Sci.; 19: No. 2-3, 51-61(Sep 1970).

Gold-198-colloid was used to study the correlation between the changes of reticuloendothelial function and scintigraphic changes following a single segmental γ irradiation of the rabbit liver with a massive dose of 3000 R to 7500 R. Reticuloendothelial function gradually decreased with increasing radiation dose. The higher the radiation dose the shorter was the period to induce functional changes. A similar trend was observed with ^{198}Au liver scintigram (CPM 30×10^3, 30% suppression) aimed at actual size projection. When the upper left lobes of the rabbit liver were irradiated, the reticuloendothelial function of the irradiated lobes decreased to less than 25% of the normal level and there was ablation of photodensity. Therefore, in order to determine the changes of ablation of photodensity it is necessary to make an evaluation with non-suppression scintigram or scintigram of less than 30%. It is considered inappropriate to evaluate the reticuloendothelial function with ^{198}Au-colloid following liver irradiation based on the uptake amount expressed in grams and therefore consideration should be given to the great effect of weight changes. (auth)

28449 GONOCYTE POPULATION OF THE GONADS OF SIX DAY OLD DUCK EMBRYOS AFTER THE IRRADIATION OF NONINCUBATED BLASTODERMS WITH X RAYS. Fargeix, Noel (Univ., Clermont-Ferrand, France). Compt. Rend., Ser. D; 273: No. 22, 2138-41(29 Nov 1971). (In French).

Nonincubated blastoderms of duck eggs were irradiated with an x-ray beam. The gonads of the developing embryos contain very few germ cells. Some of the existing cells present strong hypertrophy and may not last very long. (France)

28450 EFFECT OF LOCAL SKIN IRRADIATION WITH ^{90}Sr and ^{90}Y ON CERTAIN HEPATIC VALUES. Ghircoiasiu, Maria; Pora, E. A.; Cadariu, Maria; Uray, Z.; Clichici, M. ((Babes-Bolyai Univ., Cluj). Stud. Univ. Babes-Bolyai, Ser. Biol.; 16: No. 2, 131-9(1971). (In French).

Adult shaven rats were irradiated with ^{90}Sr and ^{90}Y over a surface of about 2 cm^2 in the femoral region. The rats were immobilized by Et_2O anesthesia. Local β irradiation of the skin did not produce histological changes, but it did influence the functional age of the hepatocytes. In the liver cells there was an immediate change after irradiation, with small nuclei predominating. After 24 hr they had returned to normal values, but the number of nucleoles was reduced. Liver glycogen decreased 24 hr after irradiation and remained low for 15 days, and then tended to return to normal values. The decrease in glycogen was attributed to alterations in phosphorylase activity. Liver cholesterol was not changed. (Selenium-Tellurium Abstr.)

28451 EFFECT OF LOCAL X-IRRADIATION OF A PRIMARY SARCOMA IN THE RAT ON DISSEMINATION AND GROWTH OF METASTASES: DOSE RESPONSE CHARACTERISTICS. van den Brenk, H. A. S.; Sharpington, C. (St. Thomas Hospital, London). Brit. J. Cancer; 25: No. 4, 812-30(Dec 1971).

Dose-effect curves obtained for growth of the primary tumour (Pr) and its metastases in unirradiated rat tissues showed that local x irradiation of Pr caused an exponential decrease in growth of metastases due to any dissemination occurring after irradiation, but was also responsible for stimulating growth of metastases already established before treatment in lymph nodes and in lungs. This effect was most marked when Pr was larger at the time of treatment and when high doses were given to eradicate Pr, and is attributed to the liberation of growth stimulating substances (GSS) from a pool of GSS produced in the irradiated Pr by sterilized, but metabolically active and growing tumor cells (HR cells). The effect of HR cells on tumor growth and metastases was also demonstrated when rats were inoculated with viable tumor cells and subsequently treated by injecting large doses of HR cells prepared in vitro, into tissues remote from the Pr tumor site. The systemic effects of GSS on metastases were most clearly seen after immunosuppression of recipient hosts by sublethal whole body irradiation, since immunosurveillance in unirradiated rats resulting from a rapidly developing allogenic tumor-host incompatibility caused marked reductions in clonogenicity of the tumor which tended to overshadow the GSS effect. The latter was also masked in immunosuppressed hosts when excessively high rates of dissemination were due to growth of large Pr inocula for sufficiently long to saturate the capacity for growth of metastatic tumor in lymph nodes and lungs. (auth)

28452 CONDITIONING RECIPIENTS OF HEMOPOIETIC CELLS WITH ANTILYMPHOCYTIC SERUM (ALS) AND PARTIAL-BODY IRRADIATION. Kolb, H.; Thierfelder, S.; Baumann, P.; Balk, O. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Neuherberg, Ger.). Rev. Eur. Etud. Clin. Biol.; 16: No. 8, 810-14(Oct 1971).

The transplantation of allogeneic, H^2-compatible, hemopoietic cells was studied by chromosomal analysis in recipient mice conditioned with a 6-day treatment of ALS, 1000 R x rays being applied to the lower half of the body including the spleen. Up to 90% of the dividing cells in the irradiated parts (spleen and femur) became of donor type within the observation period of 20 days, while less than 20% donor mitoses were found in the shielded areas of the humerus. Skin grafts of the strain of the cell donor placed on the ALS-treated, partial-body irradiated, cell-grafted recipients survived the observation period of up to 170 days. The tolerance of these skin grafts was specific. Control series untreated or treated with ALS and partial-body irradiation only rejected the skin grafts within 40 days. When preparations of cellular antigens were used instead of viable cells, the graft survival was not permanent. (France)

28453 CEREBROSPINAL FLUID FROM IRRADIATION BURROS. Wykoff, M. H. (UT-AEC Agriculture Research Lab., Oak Ridge, Tenn.). Health Phys.; 22: No. 4, 397-8(Apr 1972).

Total cholesterol, lipids, iron, alkaline and acid phosphatases, and β-glucuronidase were measured in cerebro-spinal fluid samples taken from burros irradiated with ^{60}Co γ irradiation or fission spectrum fast neutrons. All values increased with time after exposure but the difference in values could not be related to type or total dose of radiation. The amounts of total lipids, cholesterol, and iron were greatly increased above that found in the controls. Phosphatase increase appeared independent of protein increase, but β-glucuronidase levels appeared to be related. (UK)

28454 EFFECTS OF PRENATAL CONTINUOUS GAMMA IRRADIATION ON THE MACRO- AND MICROMORPHOLOGICAL ASPECTS OF ALBINO MOUSE FETUSES. Al-Jiboori, Nadhima Abdul-jabbar. College Station, Tex.; Texas A and M Univ. (1971). 70p. University Microfilms Order No. 72-5631.

Thesis.

Pregnant albino mice were continuously gamma-irradiated with daily doses of 50R and 100R from day 6 to day 16 of gestation. At day 20 of gestation the effects of continuous irradiation on the litter size, resorption rate, fetal weight, gross fetal morphology and micromorphology of specific fetal organs were studied. There was a significant reduction in the litter size of the group of mice receiving a total dose of 1000R gamma-irradiation in comparison with the litter size of the non-irradiated control group and the group receiving a total dose of 500R. The litter sizes of the last two groups did not differ from each other. Body weight of the irradiated fetuses was significantly less than that of the control. Body weight of the 1000R fetuses was also significantly less than that of the 500R fetuses. Resorption percentages in the control, 500R and 1000R groups were 2.13, 6.28 and 62.38 respectively. Other than those due to general reduction in the body size, no gross morphological malformations were observed. There was a decrease in the size of the cerebral hemispheres of the 1000R fetuses associated with a diminution of the cerebral thickness and a decrease in the chromaticity of the grey matter. The livers of the 500R fetuses showed a decrease in the hemopoietic activity, whereas those of the 1000R fetuses exhibited increased hemopoietic activity. The kidneys of the irradiated fetuses were without any remarkable histological changes from normal. Continuous irradiation did not result in significant defects in the histology of the adrenal glands of fetuses receiving a total dose of 500R, whereas 1000R induced disorganization of the cortical zona fasciculata and hyperemia of the medulla. Irradiation caused reduction in the testicular size, absence of oogonial cells and decrease of the diameter of the seminiferous tubules accompanied by increase of the interstitial tissue volume. The testes of the 1000R fetuses showed more response to irradiation than those of the 500R fetuses. Oogonial cells were also absent from the ovaries of the irradiated fetuses. The results suggested that different mammalian fetal tissues have different capabilities to repair or to resist the damage induced by different dose levels of continuous irradiation administered at specific stages of embryonical and fetal development. (Diss. Abstr. Int., B)

28455 EFFECT OF 35 MeV PROTONS ON EYES OF YOUNG BEAGLES. Horn, Peggy Loraine. Davis, Calif.; Univ. of California (1971). 73p. University Microfilms Order No. 72-9897.

Thesis.

The eyes of 12 young beagles (approximately 100 days of age) were given four doses of 35 MeV protons generated by the UCD cyclotron: 70, 125, 240, and 480 rads. Adnexal responses typical of radiation burn appeared within 7-10 days in the 480 rad-exposed dogs. More mild reactions occurred up to 8 weeks later in eyes exposed to the lower levels of radiation. Lenticular changes were observed weekly with a slit lamp biomicroscope. The opacities were assigned numerical grades to quantitate their degree of involvement. The time course relationship of the average grades for all eyes at a given dose was determined. The opacities increased in severity at a dose-dependent rate for 4.5 months, and continued until the experiment terminated, 6 months after the initial exposure. Terminally, all 480 rad-dosed eyes had complete cataracts and the 70 rad eyes showed only minimal changes. Studies of lens protein from irradiated eyes showed an increasing insolubility which correlated with the degree of cataract formation. Electrophoretic patterns of cataractic lens proteins differed from the pattern changes associated with aging. Histopathologic examination revealed vacuolated plaques on the lens, most frequently at the equator. Aberrant lens epithelial growth and distorted lens fibers were noted in all doses except 70 rad group. The 480 rad-dosed eyes also showed thinning of the corneal epithelium with vascularization at the corneal-scleral juncture. The effects of four doses of 35 MeV protons on eyes of young beagles were studied ophthalmologically, histopathologically, and biochemically. Dose dependent responses were seen in the ocular adnexa and crystallin lens. (Diss. Abstr.)

28456 SOME REFLECTIONS ON RADIATION EFFECTS IN BIOLOGICAL SYSTEMS. Sreenivasan, A. (Bhabha Atomic Research Centre, Trombay, India). pp 1-10 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

A review is presented of accomplishments in radiobiological research in various fields. In the field of radiation genetics, research on the nature of genes and chromosomes, mutations, analyses of congenital abnormalities, and awareness of genetic hazards of radiation exposure are discussed. A discussion of the scientific foundations of clinical radiotherapy includes the development of improved instruments, dosimetry, and responses of different types of cancer to radiation. A review of other applications of radiobiological research includes discussions of radioinduced mutations for improved grain yield, radiation disinfestation, and radiation-delayed ripening of fruits for commercial purposes. Reviews are also presented of radiation injury and repair mechanisms, mechanisms of radiation protection, radiosensitization, and radiomimetic agents. (H.L.W.)

28457 LIVER PROTEIN SYNTHESIS FOLLOWING WHOLE-BODY X-IRRADIATION OF RATS. Chetty, K. G.; Netrawali, M. S.; Pradhan, D. S.; Sreenivasan, A. (Bhabha Atomic Research Centre, Trombay, India). pp 159-76 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Studies were undertaken to elucidate molecular events underlying the increased protein synthetic activity in rat liver after whole-body exposure to lethal doses of x rays. It was found that the polysomal level begins to rise at the expense of monosomes 4 to 6 hr post-irradiation (1000 R and 2000 R) reaching a maximum at 18 hr and, at 36 hr, the monosome-polysome equilibrium is similar to that in unirradiated controls. The enrichment of polysomes at 18 hr post-irradiation is not due to inhibition of RNase activity. At this period, synthesis of non-ribosomal RNA of polysome is stimulated and the total ribosome population is also increased. Adrenalectomy does not affect the radiation-induced shift in the ribosomal profile indicating that this effect is not related to increased secretion of adrenal steroids in response to radiation treatment. (auth)

28458 EFFECT OF X-IRRADIATION ON GLYCOGEN METABOLISM OF LIVER AND PLACENTA OF MICE. Tarachand, U.; Eapen, Jacob (Bhabha Atomic Research Centre, Trombay, India). pp 177-89 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Hepatic glycogen levels of mice are steady throughout gestation, placental glycogen is highest on the 16th day and foetal liver glycogen increases at a progressively fast rate during the prenatal period. Liver glycogen of non-gravid and gravid mice increases 24 hours after whole body x-irradiation (500R) whereas placental and foetal glycogen levels diminish. Phosphorylase levels fluctuate in maternal liver and placenta but the enzyme of foetal liver rises steadily towards term. X-irradiation enhances the enzyme levels of only foetal liver to any appreciable extent. Incorporation of ^{14}C-glucose into glycogen of the tissues has been studied and the results are discussed. (auth)

28459 DERANGED INTESTINAL FOLATE ABSORPTION IN X-IRRADIATED RATS. Kesavan, V.; Noronha, J. M. (Bhabha Atomic Research Centre, Trombay, India). pp 191-201 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

The absorption of simple and conjugated dietary folates was severely impaired in x-irradiated rats as judged by the absence of the normally expected rise in blood folate levels after folate ingestion. While the levels of intestinal folyl conjugase were not adversely affected, there was an accumulation of folates at the intestinal tissue site and in the lumen, suggesting a defect in folate transport, especially from the gut to the blood stream. There was a significant decrease in the oxidation coupled to phosphorylation in the irradiated intestines. ATP addition was able to correct in vitro the damaged folate transport across everted intestinal segments. The evidence is also suggestive of an active mechanism of folate absorption. (auth)

28460 EFFECT OF ADENOSINE TRIPHOSPHATE (ATP) ON THE X RAY INDUCED BONE MARROW CHROMOSOME ABERRATIONS IN MICE. Manna, G. K.; Mitra, A. B. (Kalyani Univ., India). pp 393-401 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Experiments were conducted to study the effect of ATP alone, x ray alone, and pre- and post-treatment of ATP on x-ray-induced chromosome aberrations in the bone marrow cells of mice fixed at 4 and 24 hour after the treatment of 0.25 ml of 0.05% ATP solution and a dose of 200R of x-rays as required. Qualitatively aberrations were mainly chromatid type and a few exchange ones. Quantitatively the frequency of aberrations obtained in ATP series was 2.6% and 2.5%, in x-ray series 49% and 10.7%, in ATP pretreated x-ray series 23% and 5.5% and in ATP post-treated x-ray series 29.3% and 4.6% at 4 and 24 hour respectively. The data of different series have been compared. Radio-protection due to pre- and post-treatment of ATP on x-ray induced aberration frequency was more pronounced at 4 than at 24 hour. Discussions were made on the influence of ATP in rejoining and repairing the chromosome aberrations induced by x-rays. (auth)

28461 EFFECT OF X-IRRADIATION ON OVARIAN FOLLICLES IN RATS. Bhattacharjee, D.; Narurkar, M. V. (Bhabha Atomic Research Centre, Trombay, India). pp 415-29 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Damage to ovarian follicles in rats at various intervals following whole body x-irradiation (800R) was assessed in terms of degeneration and growth, employing histological, histochemical and biochemical techniques. The morphological changes were demonstrable 6 hrs. post-irradiation when degeneration of granulosa cells of antral follicles was observed. These degenerative changes became more pronounced between 12 to 24 hrs post-irradiation with the appearance of a few growing preantral follicles. At 120 hrs following x-irradiation, a preponderance of growing preantral follicles could be observed over a few degenerative antral follicles, thus indicating an almost complete recovery from the radiation damage. These observations were supported by demonstrating a complete lack of DNA synthesis in ovarian follicles at 12 hrs following x-irradiation, and a subsequent recovery by 120 hrs. It is suggested that the radiation damage in rat ovarian follicles is due to radiation sensitive mature antral follicles while the recovery is attributable to the growth of radiation-resistant dormant preantral follicles. (auth)

28462 EFFECT OF GAMMA IRRADIATION ON THE ORGANISATION OF THE CHICKEN RETINA. Bawa, S. R.; Yashroy, Rakesh C. (Punjab Univ., Chandigarh, India). pp 561-8 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Chickens were irradiated in the head region at 2000 R using a ^{60}Co γ source. Phospholipid, proteolipid, neutral lipid, deoxyribonucleic acid, ribonucleic acid, alkaline and acid phosphatases, acetylcholinesterase and glycogen were studied in the retinae of both irradiated and normal animals. Phospholipid and alkaline phosphatase increase appreciably, whereas acid phosphatase, acetylcholinesterase, deoxyribonucleic acid, ribonucleic acid decline in retinae examined a month after irradiation. The stainability of retina with Sudan Black B increases after irradiation; the glycogen-rich paraboloids of cones and hyperboloids of rods of the retinae hypertrophy in the irradiated animals. The possible significance of these irradiation changes are discussed. (auth)

28463 STUDIES ON GAMMA IRRADIATED MAMMALIAN OLFACTORY BULB. Bawa, S. R.; Moza, Ashok (Punjab Univ., Chandigarh, India). pp 569-76 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

A surface dose of 2000 R from a ^{60}Co γ unit was administered to the head of rats. The animals were sacrificed after 12 days. The cell population and fibers of the olfactory bulb of the irradiated animals were examined histologically. Nuclear material in the mitral cells seemed to concentrate significantly towards the central region of the nucleus. Cytomorphological changes due to irradiation are discussed. (auth)

28464 LOCALIZATION AND BIOLOGICAL AND PHYSICOCHEMICAL PROPERTIES OF THE CELL WALL LIPOPOLYSACCHARIDE OF RHODOPSEUDOMONAS CAPSULATA. Weckesser, J.; Drews, G.; Ladwig, R. (Univ., Freiburg i. B.). J. Bacteriol.; 110: No. 1, 346-53(Apr 1972).

Electron micrographs of phenol-water-extracted lipopolysaccharide (LPS) of Rhodopseudomonas capsulata show filamentous and netlike aggregates. Treatment of the LPS with sodium deoxycholate resulted in a reversible splitting into subunits. The LPS represents a cell wall constituent with O-antigenic specificity. In passive hemagglutination tests, high titers were obtained when erythrocytes sensitized with untreated or heat-treated LPS were incubated with antisera obtained by immunization of rabbits with whole cells of R. capsulata. The alkali-treated LPS was not active in this test. Mouse lethality tests have shown that the LPS of R. capsulata is less toxic than LPS of Escherichia coli. Also, the x-ray protection efficacy and the phagocytic activity stimulation of LPS from R. capsulata in mice are small, as compared with LPS of E. coli. Incubation of living bacteria in saline (37 C) resulted in a solubilization of an LPS-protein-lipid complex from the outer layer of the cell wall. The isolated complex contained the components which were found in the LPS. In addition, 20% amino acids and a large amount of palmitic and stearic acids, which are typical phospholipid components, were present. (auth)

28465 ERYTHROPOIETIC STEM CELL RECOVERY IN IRRADIATED POLYCYTHEMIC DOGS. Baum, S. J.; Wyant, D. E. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Amer. J. Physiol.; 222: No. 1, 92-4(Jan 1972).

The response of erythropoietic stem cells in postirradiated polycythemic dogs to 300 units of administered exogenous erythropoietin was measured. One week prior to irradiation (150 rads, mixed gamma-neutron radiation) the dogs were made polycythemic by transfused allogeneic erythrocytes. On the day of irradiation or on 10 different days during the first 3 weeks postirradiation, erythropoietin was administered and the ^{59}Fe incorporation in response to this stimulation was measured. Recovery of the erythropoietic stem cells occurred in an oscillatory manner. In general, this was ascribed to a possible slow rate of differentiation of erythropoietin-responsive cells from multipotential stem cells and a more rapid rate of proliferation of the former cells into subsequent erythrocytic progeny. As the number of divisions resulting from each cell is limited, recovery in number of cells is halted or even decreased until more cells from the slower moving multipotential stem cell compartment are released. Contributions to this oscillatory recovery pattern by chalones, or the competition of related blood cell lines for the common stem cells, however, have not been excluded. (auth)

28466 PRENATAL MATERNAL X IRRADIATION: MATERNAL AND OFFSPRING EFFECT. Ader, Robert; Deitchman, Robert (Univ. of Rochester, N. Y.). J. Comp. Physiol. Psychol.; 78: No. 2, 202-7(1972).

Rats irradiated or sham irradiated on Day 16 of fetal life were reared by irradiated or nonirradiated foster mothers in a dual-chambered maternity cage. Irradiated mothers spent less time with their litters than controls independent of the nature of the pups. Irradiated animals weighed less than controls and the prenatal effects on mortality during the immediate postweaning period were influenced by maternal factors. In addition, rats reared by irradiated mothers weighed less, were less emotional, and were more susceptible to the lethal effects of subsequent x-irradiation than animals reared by nonirradiated mothers. (auth)

28467 RADIOPROTECTION BY CATECHOLAMINES IN THE GOLDEN HAMSTER AND THE GROUND SQUIRREL. Prewitt, Russell Lawrence Jr. Columbia, Mo.; Univ. of Missouri (1971). 86p. University Microfilms Order No. 72-10,649.

Thesis.

Mechanisms of radio-protection by catecholamines were investigated in a pharmacological study involving alpha and beta blockers. Radio-protection by norepinephrine, epinephrine, isoproterenol, and phenylephrine was studied in normal and splenectomized hamsters. After whole body exposure to 1000 or 2000 rads in a ^{60}Co source the animals were individually caged and remained undisturbed for the following 30 days except to replenish food and water when needed. The per cent survivals were recorded daily. The aortic blood pressure of permanently cannulated, unanesthetized hamsters was measured with a Statham P23 DC pressure transducer and recorded on a Grass Model 7 polygraph after injections of epinephrine, phenoxybenzamine and epinephrine, and isoproterenol. The hypothesis that isoproterenol protects through a hypercalcemia mechanism was studied by measuring plasma calcium levels after treatment with propranolol and/or isoproterenol. Radio-protection by endogenous catecholamines in hibernating ground squirrels was studied by two approaches. First, tissue

levels of catecholamines were determined in 5 groups of ground squirrels: nonhibernating, hibernating 24 hours at 5 C, ambient temperature (T_A), hibernating 3 days at 5 C, T_A, hibernating 2 days at 12 C, T_A, and arousing in the cold from 6 C to 30 C, rectal temperature (T_B). The tissues analyzed were whole heart, kidneys, and adrenal glands. Secondly, the alpha blocker, phentolamine, was used in an attempt to block radio-protection in arousing ground squirrels. Hibernating animals were given phentolamine or saline (ip) and allowed to arouse. When they reached 12 C T_B they were exposed to 1450 rads whole body exposure. Unirradiated controls were given phentolamine and allowed to arouse in the usual manner. The results of these experiments show: Radio-protection by catecholamines is mediated through both alpha and beta receptors in hamsters. The effects mediated by the receptors are mutually antagonistic since stimulation of either receptor gives more protection than stimulation of both receptors at once. Beta receptors probably mediate radio-protection through a hypotension-hypoxia mechanism. Alpha receptors probably mediate radio-protection through the vasoconstriction-hypoxia mechanism. Catecholamines protect against the hematopoietic syndrome. The main locus of protection by catecholamines appears to be the bone marrow. Changes in tissue catecholamines occur during hibernation and arousal. Arousing ground squirrels appear to be protected against the effects of radiation by the release of endogenous catecholamines. (Diss. Abstr.)

28468 CELLULAR RADIOSENSITIVITY, CELL POPULATION KINETICS, AND TUMOR RADIATION RESPONSE IN TWO RELATED MOUSE MAMMARY CARCINOMAS. Rockwell, Sara Ann Campbell. Stanford, Calif.; Stanford Univ. (1971). 188p. University Microfilms Order No 72-5983.

Thesis.

A new tumor cell line, termed EMT6, was cloned from a mouse mammary carcinoma. This cell line can be grown and studied either as a tissue culture line or as a solid tumor in BALB/c mice, and it allows the tissue culture assay of cell survival after treatment of the tumors in situ. Primary explants of the untreated tumor assayed by clonal analysis in petri dishes have plating efficiencies approximating 35%. Survival curves performed simultaneously by TD_{50} and tissue culture assays yielded equivalent results. Protocols for the use of this cell line in vivo and in vitro were developed and the characteristics of the cell line in the two growth modes were examined. The growth characteristics, cell population kinetics (analyzed by the % labeled mitoses technique), antigenicity, and anoxic fraction of the tumor were studied. The effects of radiation on cell survival and tumor growth, and the dose needed to cure 50% of the tumors are reported. In tissue culture, the effect of radiation on cell proliferation patterns and cell volume was examined and survival curves for exponential and plateau phase cultures were obtained. The age-response function was determined using minicolonies obtained by mitotic selection. EMT6 tumors were irradiated in situ with two doses (D_1 = 296.5 rads, localized; D_2 = 600 rads, with tumors maximally anoxic) separated by intervals of 0–48 hours. Cyclic variations of cell survival were observed as a function of the fractionation intervals. The period of the cycle (the interval between peaks or between troughs) was approximately 10 hours. These were reproducible and not related to diurnal effects. The timing of the observed cycles was the same as that predicted from the age-response function and cell cycle time for radiosensitivity variations resulting from cell progression. This agreement supported the hypothesis that the observed radiosensitivity cycles were caused by the partial synchronization of the cells in the tumor by the first dose of radiation and the progression of the synchronous population through the states of varying radiosensitivity characteristic of different cell ages. (Diss. Abstr.)

28469 RADIOSENSITIVITY OF THE EPITHELIAL CELLS OF THE FALLOPIAN TUBE (RADIOAUTOGRAPHIC STUDY). Tilewa, M. D. (Hohes Medizinisches Institut, Plovdiv, Bulgaria). Folia Med. (Plovdiv); 13: No. 11, 75-85(1971). (In German).

It was established that the cells of the Fallopian tubes irradiated with a dose of 2000 R and implanted in the organism according to the method of F. M. Lazarenko, practically grow as the non-irradiated ones, and they preserve all the basic tissue properties characterizing the epithelium of Müller. MI‰ in the irradiated cells is lower 2 to 3 times, ^{3}HI% – 2 to 4 times, while the generation time is lengthened 3 times. The prolongation of the S-phase is not changed and is comparatively short (2.9 h). The results indicate that the cells of the tubular epithelium are relatively radioresistant. (auth)

28470 ALPHA-PARTICLE INDUCED FIBROSARCOMA; LIGHT AND ELECTRON MICROSCOPY STUDY. de Estable-Puig, R. F.; Estable Puig, J. F.; Auger, C. (Laval Univ., Quebec). Arch. Fund. Roux Ocefa; 3: 163-74(1969).

A well-differentiated fibrosarcoma was found to occur in the scalp of a rat one year after local irradiation with a 48 MeV alpha particle beam at a 6000 rad surface dose. The neoplastic fibroblasts exhibited some nuclear abnormalities: binucleation; enlargement of nuclei; irregular invaginations of the nuclear envelope; margination of chromatin; nucleolar hypertrophy; spotted nuclei and nucleoli; and presence of intranuclear inclusions containing variable number of sacs, some of them being apparently formed ex novo from the contouring envelope. The ultrastructure of their cytoplasm was indicative of the presence of two functionally different types of fibroblasts. (auth)

28471 TRANSFER BY AEROSOLS OF EFFECTS OF HIGH ENERGY SOLAR RADIATION TO THE BIOSPHERE. Campbell, M. J. (Cornell Univ., Ithica, N. Y.). Nature (London); 36: No. 5340, 26-8(3 Mar 1972).

The possibility of the existence of a pathway for the indirect transfer of high energy solar radiation injury to air-breathing animals is discussed, in that particles of stratosphere aerosol layers are exposed to high solar uv intensities and eventually descend into the lower atmosphere. Rather sharply defined layers of 0.01 to 1.0 μm particles exist at about 20 km. While the composition of stratospheric aerosols is not completely determined it is assumed that a substantial fraction is organic. In the calculations, a uniform film of dry trypsin, about 0.1 μm in thickness, is considered as a model for the effects of uv radiation on these organic aerosols. The incident flux is estimated as equivalent to 21 R/sec. γ radiation, with G = 1.2 per 100 eV for complete tryspin inactivation. It is thought that coagulation of the organic aerosols with the layer and more plentiful surface air aerosols, such as industrial pollutants, pollens, etc., will cause them to grow towards the size (0.1 to 0.3 μm) optimum for deposition in the deep alveolar regions of the lungs. Comparisons are made with radioactive fallout. It is calculated that normal surface air will transfer 7×10^{-4} erg/cm^3 of equivalent radiation energy, an amount exceeding by a factor of about 10^9 the primary cosmic ray energy density, and the energy transferred to an adult human by organic aerosols is estimated at 3.5×10^9 erg/day, representing about 7 mR/day to the blood, or 0.5 mR/day distributed over the entire body, that is, about twice the average natural background dose from all causes. Some quality of stratospheric air may also be implicated in many epidemic illnesses. (UK)

28472 CLINICAL OBSERVATIONS OF EYES OF CATTLE, SWINE, AND BURROS SURVIVING EXPOSURE TO GAMMA AND MIXED NEUTRON-GAMMA RADIATION. Brown, Daniel G.; Magrane, William G.; Cross, Fannie H.; Reynolds, R. A. (Univ. of Tennessee, Oak Ridge). Contract AT(40-1)-Gen-242. Amer. J. Vet. Res.; 33: No. 2, 309-15(Feb 1972).

Clinical observations of the eyes of cattle, swine, and burros that survived radiation exposures to gamma and mixed neutron-gamma radiation for several years were described. Significant irradiation effects were not found in the eyes of burros and swine, 6.7% of irradiated cattle were affected with opacities characteristic of radiation-induced lesions. (auth)

28473 TERMINAL DICARBOXIMIDO ANALOGS OF S-2-(ω-AMINOALKYLAMINO)ETHYL DIHYDROGEN PHOSPHOROTHIOATES AND RELATED COMPOUNDS AS POTENTIAL ANTIRADIATION AGENTS. I. PHTHALIMIDES AND SACCHARINS. Piper, James R.; Stringfellow, Carl R. Jr.; Elliott, Robert D.; Johnston, Thomas P. (Southern Research Inst., Birmingham, Ala.). J. Med. Chem.; 14: No. 4, 345-50(Apr 1971).

A number of S-2-(ω-phthalimidoalkylamino)ethyl and S-3-(ω-phthalimidoalkylamino)propyl phosphorothioates, thiosulfates, and related compounds were prepared for evaluation as radioprotective agents. Of 31 compounds of this type tested only one, S-2-(2-phthalimidoethylamino)ethyl sodium hydrogen phosphorothioate, gave fair protection in mice; eight were slightly protective, and all others nonprotective. S-2-Phthalimidoethyl thioacetate, an intermediate in the synthesis of the inactive S-2-[ω-(2-phthalimidoethylthio)alkylamino]ethyl thiosulfates and phosphorothioates, was the most active phthalimide tested. Rearrangement was noted in the last step of the conversion of 5-methyl-2-oxazolidinone into S-2-(3-phthalimidopropylamino)propyl hydrogen thiosulfate, and phthalimide ring opening precluded the conversion of N-(2-bromo-1,1-dimethylethyl)phthalimide to the corresponding tertiary-branched congeners of the title compounds. (auth)

28474 COMPARISON OF TWO ANDROGENIC HORMONES AS LEUKOPOIETIC AGENTS IN IRRADIATED RATS. Horn, Y. (Hadassah Univ. Hospital, Jerusalem). Oncology; 26: No. 1, 16-24(1972).

Two androgenic hormones testosterone propionate and mesterolone were compared for their leukopoietic activity on the bone marrow of irradiated rats. Leukocyte reserve was determined

at the end of each experiment by injecting salmonella vaccine. The whole-body x-ray dose was 400 R and different doses of both hormones were injected. Data were analyzed to compare results in both sexes, various dosages of both hormones, and differences between prophylactic and therapeutic hormonal treatments. The results revealed that both hormones accelerated recovery time of the leukocytes and a dose-sex relationship was seen in the mesterolone group only. (auth)

28475 HISTOLOGICAL EXAMINATIONS OF THE SPLEEN AFTER EXPERIMENTAL FRACTIONATED LOCAL IRRADIATION. Kovacs, L. (Univ., Budapest). Strahlentherapie; 142: No. 6, 711-20(Dec 1971). (In German).

The spleen of white rats was irradiated percutaneously in 16 fractions with a total dose of 8000 R. The changes were examined on the 1st, 3rd, 7th, 10th, 15th, 50th, 100th and 150th day after irradiation by means of different histological and histochemical methods. The registered changes may be divided into three stages. The first stage (1st to 3rd day) shows that there are no lymphocytes in the organ. An increased activity of the reticular cells which contain hemosiderin is observed. The regeneration of the lymphocytes out of the reticular cells and the circulatory system starts during the second stage (5th to 15th day). Increasing fibrous tissue growths and vascular lesions during the third stage lead to a delayed atrophy of the lymphocytes. The reticular cells do not show any pathological signs. (auth)

28476 CYTOSPECTROPHOTOMETRIC STUDIES OF DNA IN NEURONES AND GLIA OF THE SPINAL CORD OF MICE AFTER WHOLE-BODY X-IRRADIATION. Olkowski, Zbigniew (Emory Univ., Atlanta). Strahlentherapie; 9: No. 6, 706-10(Dec 1971).

Quantitative cytospectrophotometric studies on the DNA content in the motoneurones and glia in the spinal cord of whole-body x-irradiated mice were performed. No differences were found in the amount of DNA in the motoneurones, in the oligodendrocytes closely opposed to the neurones, or in the oligodendrocytes located far from the nerve cell bodies in the irradiated mice when compared to control animals. A group of tetraploid cells appeared in the ependymal epithelium of the central canal of spinal cord of irradiated mice. The significance of these changes is discussed. (auth)

28477 COMPARISON OF THE EFFECT OF HYPERBARIC OXYGEN WITH THAT OF MIXED GAS (95 PERCENT O_2 + 5 PERCENT CO_2) ON THE DEVELOPMENTAL RETARDATION OF THE TIBIAE OF YOUNG MICE AFTER IRRADIATION. Morita, K.; Ishigaki, T. (Aichi Cancer Center, Nagoya, Japan). Strahlentherapie; 142: No. 6, 695-8(Dec 1971).

The effect of hyperbaric oxygen at 3 atmospheres and inhalation of mixed gas at 1 atmosphere on the radiosensitivity of young tibiae in mice was investigated. Male mice, ddY strain, of four weeks received the irradiation of 800 R to the right-sided leg with ^{60}Co-γ-rays under several kinds of condition: in air, in mixed gas (95% O_2 + 5% CO_2) and in hyperbaric condition (3 atmospheres) of pure oxygen. Twenty-six weeks after irradiation it is observed that the tibiae, which were irradiated under the hyperbaric condition of pure oxygen, were 3.71% shorter than the control and 0.96% shorter than the group irradiated in air. These differences were statistically significant. The stunting of tibiae, which were irradiated during the inhalation of mixed gas at 1 atmosphere, showed no statistical differences from that of the group irradiated in air. The clinical significance of these results is discussed. (auth)

28478 CHEMICAL SENSITIZATION TO RADIATION DAMAGE IN RAT EMBRYOS. Michel, Christian (Univ., Zurich). Arch. Julius Klaus-Stift. Verebungsforsch., Sozialanthropol. Rassenhyg.; 43: 177-203(1968). (In German).

Rat embryos at nine days of gestation were irradiated with x rays in utero with 12½, 25, 50, 75, and 100 R and examined 4 days after irradiation. Radiation doses of 12½ R caused eye anomalies and an increase of chromosome aberrations. Brain damage was observed after exposure to 25 R. The malformations increased proportional with doses and reached 90.4% after exposure to 100 R. Postnatal examinations performed with 25 day-old rats did not show any reversibility of embryonic malformations. A combined administration of iodoacetamide (IA) with exposure to low doses increased the embryonic damage. The effect of IA as radiosensitizer was synergistic, causing the most significant increase in radiation damage at doses ranging from 25 to 75 R. Problems concerning the causes for the development of malformations and some possible mechanisms of IA action are discussed. The incidence of numerous chromosome aberrations and cell degenerations, which also were enhanced by IA, hints at the possible causes of embryonic malformations. It is assumed that the radiosensitizing action of IA is a result of an inhibition of immediate repair processes, that depend on the cellular energy metabolism. (auth)

28479 ABSORBED DOSE TO THE CELLS OF BONE PART I. Spiers, F. W. (Univ. of Leeds, Eng.). pp 213-26 of Radiation Dosimetry. Vol. 1. /Mirac, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

Methods for the measurement of absorbed radiation doses in bones following exposure to external sources of γ or x radiation are discussed. The macroscopic and microscopic structure of bone is reviewed and it is pointed out that for dosimetric purposes bone is considered to consist of two components, the hard mineralized matrix and the soft tissue lying close to or enclosed within the matrix. (C.H.)

28480 EFFECTS OF FAST NEUTRON IRRADIATION ON BLOOD PRESSURE AND THE RESPONSE TO EPINEPHRINE AND ACETYLCHOLINE IN THE RAT. Wykoff, M. H. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Contract AT(40-1)-Gen-242. Radiat. Res.; 49: No. 3, 624-30(Mar 1972).

The effects of fast neutron irradiation on the systemic blood pressure and its response to epinephrine and acetylcholine were investigated. Two groups of 10 rats were observed at 4, 24, and 48 hrs after exposure to 700 rad fast neutrons. One group received injections of 10 μg epinephrine and the other group injections of 20 μg acetylcholine. Blood pressure was monitored by direct cannulation of the carotid artery. Systemic blood pressure fell with time after irradiation. Fast neutron irradiation decreased the time to reach the observable maximum pressure response and accelerated the decay of this maximum response. No measurable alterations in the response to acetylcholine were observed in the irradiated groups. (auth)

28481 EFFECTS OF IONIZING RADIATION ON SURVIVAL, LONGEVITY, AND REPRODUCTION IN FREE-RANGING POCKET MICE, PEROGNATHUS PARVUS. O'Farrell, Thomas P.; Hedlund, John D.; Olson, Richard J.; Gilbert, Richard O. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Radiat. Res.; 49: No. 3, 611-23(Mar 1972).

There was no significant difference between the responses of captive and free-ranging Great Basin pocket mice, Perognathus parvus, to ionizing radiation. The $LD_{50(30)}$ ± SD values were 858 ± 27 rad and 834 ± 32 rad, respectively, and the slopes of both survival curves were parallel. Although some unconfined mice lived 3 yrs postirradiation, the median longevity was 12 months or less for all dose levels. Median longevity appeared to be inversely related to absorbed dose above the threshold exposure: 675 rad. Radiation-induced sterility was not evident in free-ranging males, but all irradiated females appeared to be permanently sterile in subsequent breeding seasons. Pocket mice were able to survive secondary effects including: swelling and eversion of cheek pockets; depilation; and a change in coat color from tan to white. (auth)

28482 LATE PATHOPHYSIOLOGIC CHANGES IN HEAD X-IRRADIATED DOGS; REVIEW AND CLINICAL CORRELATIONS. Kramer, Melvyn W.; Michaelson, Sol M. (Univ. of Rochester, N. Y.). Radiat. Res.; 49: No. 3, 563-88(Mar 1972). (UR-49-1495).

Two and one-half years after exposure to 1000 R head x irradiation (1 MeV, dorsal aspect, MAD, at 5, 50, and 500 R/min), mongrel dogs were studied for late pathophysiologic effects. Neurologic studies indicate subtle deficiencies in motor reflexes, in ophthalmologic reflexes, and a general hyperkinesia, all being more marked in the 500 R/min group. Electroencephalography under surgical pentobarbital anesthesia revealed generally slower, higher voltage activity. Generalized slowing, focal slowing, spike-like activity and rhythm instability were also observed in all irradiated dogs regardless of exposure rate and with greater frequency in posterior cranial leads. Intolerance to anesthesia was observed in higher exposure rate animals. Electrocardiography revealed alterations in ventricular electrical systole. T-wave alterations, Q-T delay, and SGOT elevation in all irradiated dogs was similar to that observed after cerebral vascular catastrophe, and brain electrical stimulation with myocardial necrosis. Results are consistent with subclinical or low-grade progressive cardiomyopathy thought to result from an autonomic imbalance or hyperactivity. Total evidence presented indicates experimental animals are in a subacute or chronic clinical phase 2.5 yrs after head irradiation characterized by subtle neurologic, neurophysiologic, and pathophysiologic alteration of various bodily functions. Slow progression of central neural alteration appears likely, the resolution of which may be characterized as a syndrome of a late radiation encephalopathy. (auth)

28483 MITOCHONDRIAL PROTEIN AND RNA SYNTHESIS OF X-IRRADIATED MOUSE LIVERS. Mukerjee, Himansu; Goldfeder, Anna (New York Univ., N. Y.). Radiat. Res.; 49: No. 3, 543-57(Mar 1972).

The effects of 2000 R on protein and RNA synthesis of mouse liver mitochondria were determined. After 40-min injection in vivo of ^{14}C-leucine or ^{3}H-uridine, the uptake of both isotopes by the irradiated liver mitochondria was 80% and 36% higher respectively than control. Mitochondria from x-irradiated livers also incorporated 40% more ^{14}C-leucine and 12% more ^{3}H-UTP during 40 min incubation in vitro at 37°C than control. The distribution of nascent protein and RNA in submitochondrial fractions after in vitro incorporation of ^{14}C-leucine or ^{3}H-UTP indicated that the mitochondrial membrane fraction from x-irradiated livers incorporated 12.5% more ^{3}H-UTP and 34% more ^{14}C-leucine. The supernatant (excluding mito-ribosomal particles) incorporated 58.5% more ^{3}H-UTP and 103% more ^{14}C-leucine than control. The sedimentation profile of mito-ribosomes of control showed a higher proportion of particles in the 87S to 32S region and gave about 60% of the total ^{14}C-leucine counts, whereas mito-ribosomal aggregates below 32S of the x-irradiated livers gave about 60% of the total ^{14}C-leucine counts. Gel electrophoretic profiles of labeled mitochondrial RNA showed that about 45% higher 21S RNA and 50% higher 4S RNA were synthesized in x-irradiated liver mitochondria as compared to control. The higher levels of protein and RNA synthesis are explained by the increased transport of RNA and protein precursors due to change in mitochondrial membrane permeability induced by x-irradiation. (auth)

28484 RADIOPROTECTIVE EFFECT OF RAUSCHER LEUKEMIA VIRUS IN THE SJL/J MOUSE. Okunewick, James P.; Fulton, Doris; Markoe, Arnold M. (Allegheny General Hospital, Pittsburgh). Radiat. Res.; 49: No. 3, 521-9(Mar 1972).

Experiments were performed to study the radiosensitivity of mice with Rauscher virus induced leukemia. Development of the leukemia was evaluated by measurements of the changes in spleen weight, leukocyte count and differentials, and hematocrit. Thirty-day survival of Rauscher virus injected mice was compared with that of normal mice following: no irradiation, 490, 650, 700, 750, 800, 850, 900, 950, 1000, 1050, and 1100 R of x rays. Thirty-day survival of Rauscher infected mice given no irradiation was only 36%. This was increased to 100% by exposure to 490 R of x rays. From 490 to 750 R the effect of irradiation on both normal and Rauscher infected mice was equivalent. However, from 800 through 1050 R, the leukemic mice showed a notably greater radioresistance than did irradiated normal mice. Thirty-day survival of leukemic mice after exposure to 800 R was twice as great as that of normal mice (80% vs 40%). At 900 R and above none of the normal mice survived for 30 days after the irradiation. In contrast the leukemia virus infected mice showed a 30-day survival of 36% at 900, 24% at 950, and 4% at 1050 R. The data indicate that through some means, yet to be determined, development of Rauscher leukemia in the mouse confers a significant radioresistance to the viral infected animal. (auth)

28485 THERAPY OF RADIATION INJURY BY FOREIGN MARROW GRAFTS: A STUDY OF HEMATOPOIETIC STIMULATION AND REVERSION TO AVOID THE CONSEQUENCES OF SECONDARY DISEASE. Kinnamon, Kenneth Ellis. Memphis; Univ. of Tennessee (1971). 223p. University Microfilms Order No. 72-10,417.

Thesis.

An experimental mouse model of radiation injury and hematopoietic restoration was used to investigate the feasibility of stimulating and replacing radiation injured hematopoietic tissue. These two approaches, stimulation and replacement of the injured hematopoietic tissue, were employed to assist lethally irradiated mice over the radiation crisis period, and to attempt to prevent the fatal consequences of the ensuing secondary disease. Emphasis was placed on using rabbit anti C57B16 strain mouse serum to remove the C57B16 strain mouse cells and to prevent the graft rejection reaction. Further emphasis was placed on treatment with erythropoietin (EP) and prolactin to promote the return of the irradiated and grafted animals' own hematopoietic system. Normal rabbit serum (NRS) as well as isotonic saline was used as a control treatment agent. Methods used for this study included the spleen colony assay, Simonsen assay for cellular reactivity, polycythemic mouse assay for evidence of erythropoiesis stimulation, electrophoresis for detecting donor-host hemoglobin patterns, an in vivo graft confirmation assay, and other hematological and histological procedures. Both ALS and EP were effective in reducing cellular immunologic reactivity as determined by the Simonsen assay. ALS, NRS, and EP treatment of unirradiated mice resulted in a lymphopenia which may be due to toxicity of the treatment agent or antigenic stress. EP and ALS treatment caused a marked neutrophilia in unirradiated mice. These two therapeutic agents may be operating by exceeding the "carrying capacity" of the stem cell microenvironment. The data are consistent with the idea that ALS is detrimental to the hematopoietic system. This contention is supported by a decreased iron uptake in ALS treated polycythemic mice, fewer macroscopic spleen colonies after recipient or donor treatment, and splenic lymphoid hypoplasia after ALS therapy. (Diss. Abstr.)

Invertebrates

28486 EXPERIMENTAL STUDIES ON THE IMMUNOLOGY OF SCHISTOSOMA INCOGNITUM CHANDLER 1926 VACCINATION WITH GAMMA-IRRADIATED CERCARIAE AND PASSIVE TRANSFER. Tewari, H. C.; Biswas, Gita (Indian Veterinary Research Inst., Izatnagar) Z. Parasitenk.; 38: 48-53(1972).

The effect of various doses of gamma irradiation on the development of Schistosoma incognitum cercariae have been investigated in mice. A marked resistance to a subsequent challenge infection with normal cercariae was observed in mice doubly vaccinated with irradiated cercariae. Experiments on the passive transfer of immunity had failed to demonstrate a significant degree of resistance by this vaccination procedure. (auth)

28487 EFFECT OF ^{60}Co RADIATIONS ON SEXUAL AND CHEMICAL ATTRACTION OF ORTHOTOMICUS EROSUS WOLL., POLYGAMOUS COLEOPTER SCOLYTIDAE. Chararas, Constantin; M'Sadda, Kacem (Institut National Agronomique, Paris). Compt. Rend., Ser. D; 273: No. 20, 1877-9(15 Nov 1971). (In French).

Polygamous Scolytidae Coleopters Orthotomicus erosus Woll., (a specific parasite of conifers) were irradiated with various intensities of ^{60}Co radiation in order to investigate the behavior changes produced, changes in chemical and sexual attraction, nutrition problems, and the mortality of phase I adult insects (adults with clear pigmentation being nourished from the original biotope), phase II insects (insects with brown pigmentation at the end of the maturing nutrition), and phase III insects (at the moment of emergence marked by coupling activity and a positive phototropism). (France)

28488 EFFECT OF NATURAL IONIZING RADIATION ON THE PRODUCTION OF A SPONTANEOUS MUTATION IN DROSOPHILA MELANOGASTER. Giess, M. C.; Planel, H.; Blanquet, Y. (Univ., Toulouse). Compt. Rend. Soc. Biol.; 165: No. 3, 706-9(1971). (In French).

A significant attenuation of the natural ionizing radiation intensity during the breeding of Drosophila flies did not lead to any modification in the mutation frequency. Natural ionizing radiation does not account for one in a thousand of the spontaneous mutations occurring. (France)

28489 EFFECT OF GAMMA IRRADIATION ON DEVELOPMENT OF RICE MOTH (CORCYRA CEPHALONICA). Raghavan, K. G.; Nadkarni, G. B.; Sreenivasan, A. (Bhabha Atomic Research Centre, Trombay, India). pp 151-8 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Larvae of the rice moth (Corcyra cephalonica) exposed to gamma-irradiation (0-200 Krad) showed loss in body weight, prolongation of larval period, and reduction in web formation. The incorporation of administered leucine-1-^{14}C into body proteins was considerably lowered in irradiated larvae with most of the radioactivity recoverable in protein free supernatant of the haemolymph. The amino acid composition of the web of larvae showed absence of sulphur-containing amino acids. The homogenates of rice moth larvae developed black pigments on standing. This has been correlated with phenol oxidase activity, having a dual role in oxidative metabolism and in cuticle formation, which was essentially present in the supernatant (18,000 × g). The exposure of the insects to gamma-rays brought about increase in activity proportional to the dose of irradiation. The premature activation of this enzyme after irradiation could be one of the factors for the failure of pupation and subsequent adult emergence. (auth)

28490 RADIATION-INDUCED BEHAVIOURAL MODIFICATIONS AS A MEASURE OF RADIOSENSITIVITY OF MALE KHAPRA BEETLE (TROGODERMA GRANARIUM EVERTS). Adeesan, C.; Rahalkar, G. W.; Tamhankar, A. J. (Bhabha Atomic Research Centre, Trombay, India). pp 373-80 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Pheromone-mediated recognition between sexes is a common phenomenon in many insect species. In such situations it is possible to measure quantitatively the response of the male to the female sex pheromone. The feasibility of using such behavioral response as a viable parameter for measuring radiosensitivity was investigated. The proportion of males responding to the pheromone was considerably reduced after gamma irradiation. The reduction in male responsiveness was proportional to the radiation dose and was dependent on the developmental stage at irradiation. (auth)

28491 TEMPERATURE INDUCED MODIFICATION OF RADIOSENSITIVITY IN KHAPRA BEETLE (TROGODERMA GRANARIUM EVERTS) LARVAE. Rahalkar, G. W.; D'Souza, Anne P. (Bhabha Atomic Research Centre, Trombay, India). pp 381-91 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Modifying influence of temperature, during and after irradiation, on the radiosensitivity of khapra beetle larvae was investigated. Larvae irradiated with gamma rays at low temperature exhibited reduced radiation damage, there being greater incidence of pupation when irradiated at 0°C than at 30°C. Larvae irradiated at room temperature recovered from radiation injury when kept under diapause for 10 days. The recovery was discernible in terms of pupation at all dose levels (5,6,8 and 10 Krads) and adult emergence only in 5 and 6 Krad dose treatments. Results are discussed in the light of available information on the subject. (auth)

28492 REPLICATIVE AND TRANSCRIPTIVE ACTIVITIES OF THE POLYTENE X-CHROMOSOME OF MALE DROSOPHILA MELANOGASTER AFTER X-IRRADIATION. Lakhotia, S. C. (Univ. of Calcutta). pp 477-87 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

DNA and RNA syntheses on the polytene X-chromosome of male Drosophila melanogaster have been analyzed by ^{3}H-thymidine and ^{3}H-uridine autoradiography following x irradiation (1KR) of late third instar larvae. It has been shown that x irradiation causes a selective reduction in the width of the normally inflated male X-chromosome. DNA replication patterns of the male X were analyzed in detail and a comparison of the present observations with the data obtained earlier for control male and female polytene nuclei in D. melanogaster shows that following x irradiation, the replicative organization of the male X is in many respects similar to that exhibited by the female X's. Similarly, RNA synthesis by the normally hyperactive male X is relatively reduced following x irradiation. It is concluded that the hyperactivity of the polytene X-chromosome in male Drosophila, with respect to DNA and RNA synthesis, is related to its enlarged width and that in D. melanogaster this hyperactivity of the male X is repressible by external nucleoprotein metabolic inhibitors. (auth)

28493 VIRUSLIKE PARTICLES IN THE TISSUES OF NORMAL AND γ IRRADIATED DROSOPHILA MELANOGASTER. Miquel, Jaime; Bensch, Klaus G.; Philpott, Delbert E. (Ames Research Center, Moffett Field, Calif. Stanford Univ., Calif.). J. Invertebr. Pathol.; 19: No. 1, 156-9(Jan 1972).

One-day old imagoes of Drosophila melanogaster were exposed to 50 kR of ^{60}Co gamma rays at 4350 R/min. The mean life spans of unirradiated and irradiated flies were 95 and 30 days respectively. Electron microscope observations revealed the presence of virus-like particles in the midgut, fat body, oenocytes, salivary glands, brain, nerve and muscle of both control and irradiated flies. The highest concentrations of particles were found in irradiated flies that were 30 days old. (H.L.W.)

28494 TECHNIQUE FOR REVEALING HIDDEN HETEROZYGOSITY ON AUTOSOME 3 OF THE HOUSE FLY. McDonald, Ian C. (Dept. of Agriculture, Fargo, N. Dak.). J. Hered.; 62: 45-7(Jan-Feb 1971).

A mating sequence, utilizing a crossover suppressor and mutant markers, has been devised to reveal hidden genetic loads on autosome 3 of the house fly. Recessive lethal factors were isolated in preliminary tests involving x-ray treated house fly sperm. (auth)

28495 REDUCTION OF POPULATIONS OF CAGED CABBAGE LOOPERS BY RELEASE OF IRRADIATED MALES. Toba, H. H.; Kishaba, A. N.; North, D. T. J. Econ. Entomol.; 65: No. 2, 408-11(Apr 1972).

A single release (9:1 treated vs untreated) of male Trichoplusia ni (Hübner) that had been irradiated with a substerilizing dose of gamma irradiation (15 krad) reduced an untreated cage population by 92% within 2 generations. When males were completely sterilized (30 krad) and released in the same manner, the reduction was only 82%. Increased control obtained with substerile males is attributed to inheritance of sterility by the F_1 progeny; completely sterile males can affect only the progeny of the parent generation. Release of substerile male moths into a natural population appears to be a practical method of insect control. (auth)

28496 COMBINATION OF GAMMA AND MICROWAVE RADIATION FOR CONTROL OF THE ANGOUMOIS GRAIN MOTH IN WHEAT. Tilton, Elvin W.; Brower, John H.; Brown, Gary A.; Kirkpatrick, Robert L. (Agricultural Research Service, Savannah, Ga.). J. Econ. Entomol.; 65: No. 2, 531-3(Apr 1972).

Samples of soft red winter wheat containing known ages of eggs, larvae, or pupae of Sitotroga cerealella (Olivier) were irradiated with gamma and/or microwave radiation. Representatives of each age group received the following treatments: no radiation (controls), microwave radiation, gamma radiation, microwave radiation followed by gamma radiation, or gamma radiation followed by microwave radiation. Effectiveness of the treatments was based on percent adult emergence. An average reduction in emergence of 54 and 74% was observed following gamma and microwave radiation, respectively. The calculated expected reduction was 88% for combination treatments of either sequence. The sequence of radiation treatments did not influence the average effectiveness of the combinations. When the gamma treatment was followed by microwave radiation, the average reduction in emergence was 96%; when microwave radiation was followed by gamma radiation, the average reduction was 97%. (auth)

Radionuclide Effects (Internal Source)

Man

Refer also to abstract 28427.

28497 (BNL-16613) STERNGLASS: A CASE HISTORY. Hull, Andrew P. (Brookhaven National Lab., Upton, N. Y.); Shore, Ferdinand J. (Queens Coll., New York). [1971]. 39p. (CONF-720310-1). Dep. NTIS.

From Atomic Industrial Forum conference on nuclear public information; Los Angeles, Ca. (5 Mar 1972).

On the basis of established dose-effect relationships, the average population doses produced by nuclear facility effluents are found to be orders of magnitude too small to produce infant mortality. Infant mortality is so strongly correlated with other variables, such as socio-economic circumstances, as to obscure the possibility of making meaningful studies of low-level radiation effects of nuclear facility produced exposures. (TSS)

28498 MICRODOSIMETRY OF ^{125}I IN HYPERTHYROIDISM. Reddy, A. R.; Sastry, K. G. K.; Gupta, M. M.; Nagaratnam, A. (Inst. of Nuclear Medicine and Allied Sciences, Delhi). pp 711-19 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

For the management of hyperthyroid patients, ^{125}I was found to be more effective than ^{131}I. At macroscopic levels, ^{131}I appeared to be more effective than ^{125}I on a rad or rem basis. A more detailed study of the dosimetry at the cellular level indicated that ^{125}I and ^{131}I were equally effective. However, the dose distributions to different parts of the cell were significantly different. The dose of ^{125}I to the nucleus of acinar cells was smaller than the dose to the cell membrane; the dose of ^{131}I was the same to both. Biological effects of the decay of ^{125}I to ^{125}Te are discussed. (H.L.W.)

28499 CRETINISM ASSOCIATED WITH MATERNAL SODIUM IODIDE ^{131}I THERAPY DURING PREGNANCY. Green, H. Gordon; Gareis, Frank J.; Shepard, Thomas H.; Kelley, Vincent C. (Univ. of Washington, Seattle). Amer. J. Dis. Child.; 122: 247-9(Sep 1971).

Severe hypothyroidism developed in a 4-year-old girl whose mother received four courses of sodium iodide ^{131}I therapy during pregnancy. Mechanisms of fetal thyroid damage by radioactive iodine include placental transfer, possible concentration of radioactive iodine by the fetal thyroid gland, and possible ablation or partial damage of the fetal thyroid gland by radioactive iodine.

Any infant whose mother received ^{131}I during pregnancy should receive careful long-term follow-up. (auth)

28500 GENERAL PRINCIPLES OF INTERNAL EXPOSURE. Snyder, Walter S. (Oak Ridge National Lab., Tenn.). pp 87-107 of Radiation Dosimetry. Vol. 1. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

Methods used for calculations of the total radiation dose absorbed by the whole body and specific organs of man following radioisotope uptake are discussed. The relation of single intake and chronic exposure, metabolic factors affecting radioisotope uptake and retention, and the energy and decay scheme of the radioisotope to the radiation dose absorbed are considered. Sources of data on the energy released during the decay of some 300 radioisotopes, based on computer calculations, are given. Sources of data on the fraction of energy absorbed by target organs from radioisotopes deposited in source organs are also given based on computer calculations of the decay scheme of some 54 radioisotopes of medical interest. Formulas for the calculation of dose equivalent instead of dose are given. It is pointed out that maximum permissible concentration values for radioisotopes are computed on the basis of a constant level of exposure, which is a very artificial premise that is seldom realized in any practical situation, since in most cases the exposure occurs sporadically and that the application of models of radioisotope retention in calculations of internal radiation dose often leads to errors. (C.H.)

28501 ESTIMATION OF ABSORBED FRACTION OF ENERGY FROM PHOTON SOURCES IN BODY ORGANS. Snyder, Walter S. (Oak Ridge National Lab., Tenn.). pp 108-35 of Radiation Dosimetry. Vol. 1. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

Problems involved in estimating the radiation dose to human body organs from a radioisotope point photon source deposited in the body are discussed. It is pointed out that the problem is complicated by the fact that the body is not homogeneous and in some cases the shape of the organ is irregular. A Monte Carlo type computer code was designed to account for the geometrical shape of the body and of the major internal organs, the different densities and compositions of the various body tissues, and the multiple scattering of photons in the body during estimations of internal radiation dose. A geometrical human body phantom with internal organs was developed for use in computer calculations of the absorbed fraction of energy in selected target tissues from a point source of photons in selected body organs. The elemental compositions of the lungs, skeleton plus bone marrow, and the remainder of the phantom as a factor of organ density are represented in the calculations of absorbed dose as a function of photon energy. A survey of typical results is included. Various procedures used for adjusting the absorbed fraction for different masses of the target organ and changes made in the phantom to obtain the dose to red bone marrow are described. (C.H.)

Animals

28502 ROENTGENOGRAPHIC ANALYSIS OF ^{226}Ra INDUCED OSTEOGENIC SARCOMA IN MICE. Svoboda, V.; Globocnik, E.; Kofranek, V. (Inst. of Hygiene and Epidemiology, Prague). Neoplasma; 18: No. 6, 599-606(1971).

The roentgenograms of osteogenic sarcomas in random bred mice of H strain induced by two intraperitoneally injected levels of ^{226}Ra activity (7.3 μCi/kg and 18.0 μCi/kg), were evaluated. The roentgenograms were produced on microstructural apparatus and studied at up to 17.5 × magnification. In the group of 121 mice with lower activity, 18 osteosarcomas in 17 mice were determined roentgenographically and histologically. In the group of 101 mice with higher activity, 15 osteosarcomas were ascertained in 14 animals. The osteogenic sarcomas in both given groups were found to differ as a whole in cumulative incidence and anatomic localization, i.e., they occur earlier in the group with higher activity, concentrating almost completely on the axial skeleton and manifesting by striking sclerotization and osteoplasia. ^{226}Ra-induced osteogenic sarcomas manifest—as a whole—radiographically with a different degree of sclerotization and osteoplasia. This is probably in correlation with the histopathology of tumors characterized by osteoblast-like cells that maintain a varied degree of neoplastic-bone formation. (auth)

28503 ALTERATIONS OF THYROID MORPHOLOGY IN MICE BY RADIOACTIVE PHOSPHORUS. Dev, P. K.; Srivastava, P. N. (Univ. of Rajasthan, Jaipur, India). Strahlentherapie; 142: No. 5, 590-3(Nov 1971).

Adult albino mice were injected with 2 μCi of ^{32}P/g body weight and autopsied on the 2nd, 4th, 6th, 8th, and 10th day post irradiation. Histopathological studies on the thyroid glands were made that revealed damage in the late intervals causing distortion of follicles especially the smaller ones. In a few cases, edematous nature of connective tissue was noticed. The effects are discussed in the light of relevant literature on x-irradiated and ^{131}I-irradiated animals. (auth)

28504 HEMATOLOGICAL EFFECTS OF ^{32}P IN SWINE. Reddi, O. S. (Osmania Univ., Hyderabad, India). Indian J. Med. Res.; 59: No. 8, 1245-53(Aug 1971).

Hematological studies on the peripheral blood of swine after intraperitoneal administration of ^{32}P in doses of 1, 3, 10, and 20 mCi indicated a decrease in hemoglobin, hematocrit, lymphocytes, and reticulocytes. These are sensitive indicators of acute and subacute radiation effects. Each of these cells exhibited a dosage effect either in sensitivity or recovery. The relative sensitivities of these cell types were evaluated. (auth)

28505 ABSORBED DOSE TO THE CELLS OF BONE. PART II. THE DOSIMETRY OF INTERNALLY DEPOSITED RADIONUCLIDES. Spiers, F. W. (Univ. of Leeds, Eng.). pp 227-43 of Radiation Dosimetry. Vol. 1. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

Methods for the measurement of absorbed radiation doses in bones following the uptake of radioisotopes are discussed. Radiation doses to both the soft tissues and bone matrix are considered. Emphasis is placed on methods for estimation of the dose rates from β particles following the uptake of ^{14}C, ^{45}Ca, ^{18}F, ^{22}Na, ^{32}P, ^{90}Sr, or ^{90}Y using single or multiple cavity calculations. The use of fine-grain lithium fluoride or lithium borate powders as thermoluminescent dosimeters for measurements of the radiation dose following introduction into the cavities in trabecular bone specimens is discussed briefly. (C.H.)

28506 EFFECT OF ^{90}Sr ON GONADAL CELL KINETICS IN MICE. Reddi, O. S.; Reddy, P. P.; Pramila Rani, K.; Vijayalaxmi, C. (Osmania Univ., Hyderabad, India). Indian J. Anim. Sci.; 41: No. 5, 377-80(May 1971).

Investigations on the possible hazards in the use of internally administered radioisotopes in human medicine, either as therapeutic or diagnostic agents before or during child-bearing age, are of late gaining importance. Studies on ^{32}P have indicated such possibilities and the present investigations with ^{90}Sr in mice also show similar results. It may be noted that in both spermatogonia and oocytes the sensitivity increases steadily with the dose administered. A 2μCi dose produced a cell-killing of about 47 per cent of RPS, 34 percent of A and B spermatogonia, and 28 per cent of primary and secondary oocytes. Further, an observed dominant lethality of 12.26 per cent at 18 μCi given to males and 8.46 per cent at 10 μCi given to females also confirm the possible hazards of the use of ^{90}Sr in human medicine. (auth)

Microorganisms

28507 BIOLOGICAL CONSEQUENCES OF THE DECAY OF RADIOACTIVE PHOSPHORUS INCORPORATED INTO THE CELLS OF MICROORGANISMS. Gracheva, L. M.; Korolev, V. G. (Ioffe Inst. of Physics and Tech., Leningrad). Usp. Sovrem. Biol.; 72: No. 1, 143-58(1971). (In Russian).

A review is presented of literature on the lethal, mutagenic, and recombination effects of ^{32}P incorporated in the intracellular structures of various microorganisms: phages, bacteria, and fungi. Literature data on the restoration of single strand and double strand breaks of DNA induced by the decay of incorporated ^{32}P are discussed. On the basis of analyses of the biological and chemical consequences of the radioactive decay of ^{32}P, an outline of the lethal and nonlethal changes which may be produced in the structure of DNA is proposed. (43 references) (JPRS)

Nuclide Kinetics and Toxicology

28508 UPTAKE AND ELUTION OF RADIOSODIUM IN BONE POWDER: COMPARISON WITH ^{47}Ca AND ^{85}Sr. Forbes, Gilbert B.; Zalenski, Dennis (Univ. of Rochester, N. Y.). Calcified Tissue Res.; 8: No. 2, 172-6(1971). (UR-49-1434).

A column constructed of defatted bone powder can discriminate between ^{22}Na and ^{85}Sr or ^{47}Ca. Sodium is taken up, and eluted, from such a column at a more rapid rate than the other two isotopes. These observations make it unnecessary to assume the existence of an active process as a major explanation for the

differential behavior of Na and these multivalent cations in bone in vivo. (auth)

Man

28509 (BARC-565) SOME ASPECTS OF AEROSOL DEPOSITION IN THE HUMAN LUNG. Subba Ramu, M. C. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 46p. Dep. NTIS (U. S. Sales Only).

Some of the problems involved in experimental and theoretical studies made on the fractional recovery and deposition of inhaled radioactive particles are discussed. The effects of physiological parameters, airflow pattern in the human respiratory tract, mixing between different lung volumes, and physical properties of the aerosol (both radioactive and non-radioactive) on aerosol deposition in human lungs are briefly discussed. Although the existing theories are satisfactory for obtaining qualitative trends of the variation of total and regional depositions with particle size, the calculations of exact deposition values, their variation with tidal volume, breathing frequency and resting expiratory level, depend on reliable and reproducible experimental results. Monodisperse aerosols can be conveniently and safely used for the estimation of deposition since their size and concentration in the inhaled and exhaled air can be measured accurately. Also the risk involved in breathing the aerosol is negligibly small if the material of the aerosol is non-toxic and chemically inert. For obtaining reproducible values of deposition, it is essential to take into account the fundamental aspects of the influence of the various physiological parameters on deposition. Some studies show that the expiratory reserve volume has a greater influence on deposition than the tidal volume. Experiments using 0.5 μm dia. particles are useful in the study of the distribution and mixing of air within the lung that are highly necessary to understand the mechanism of deposition of particles in the human lung. Results are reported from a detailed experimental investigation on the various aspects of distribution and deposition of ions, nuclei, and charged and uncharged particles in the lung following single and continuous inhalation of aerosols. Applications of the findings for understanding the occurrence of lung cancer in uranium mine workers, who breathe an excess of radon, and for a realistic evaluation of the risk due to fallout pollutants in urban air are discussed. The studies are also useful in the field of inhalation therapy. (39 references) (auth)

28510 RADIOSTRONTIUM DEPOSITION IN THE SKELETON OF OSTEOPOROTIC PATIENTS. SCINTIGRAPHIC INVESTIGATIONS WITH ^{85}Sr. Bessler, W.; Kappeler, H. (Roentgeninstitut des Kantonsspitals, Winterthur, Switzerland). Schweiz. Med. Wochensch.; 101: No. 43, 1545-9(30 Oct 1971). (In German).

Scintigraphic examination of patients with osteoporosis demonstrates abnormally high storage of ^{85}Sr in the vertebral spine. Calcium turnover appears to be accelerated in these cases. Osteoporosis is usually due to an increase in the bone absorption rate, also leading to a reactive increase of bone accretion. Measurement of the count rates provides relative information on the amount of radioactivity deposited in the different parts of the skeleton. In patients with advanced osteoporosis combined with vertebral fractures, the avidity of the skeleton for radiostrontium is greatly increased. After therapy with steroids relatively low uptake of radiostrontium is noted in the skeleton. (auth)

28511 IN VIVO DETERMINATION OF THE LATE-PHASE LUNG CLEARANCE OF ^{239}Pu FOLLOWING ACCIDENTAL EXPOSURE. Johnson, L. J.; Dean, P. N.; Ide, H. M. (Los Alamos Scientific Lab., N. Mex.). Health Phys.; 22: No. 4, 410-12(Apr 1972).

In Vivo measurements were made with an NaI(Tl)-thick CsI(Tl) crystal "Sandwich" system, on an individual following accidental inhalation. A particle mass median dia of about 0.30 μm with a typical geometric standard deviation of 1.4 was indicated. The time of the initial exposure was unknown and the counts were continued for 430 days after discovery. A clearance half period of 240 days was observed. (UK)

28512 IODINE KINETICS IN PATIENTS WITH THYROID CANCER TREATED WITH LARGE DOSES OF ^{131}I AND COMPUTATION OF RADIATION DOSE TO VARIOUS BODY ORGANS. Singh, B. (Bhabha Atomic Research Centre, Trombay, India. Tata Memorial Hospital, Bombay); Sharma, S. M.; Patel, M. C.; Raghavendran, K. V.; Berman, M. pp 577-89 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

A number of workers have attempted to work out iodine kinetics based on mathematical models having three to 11 compartments. Unsteady state kinetics of iodine metabolism was studied in thyroid carcinoma patients treated with large doses of ^{131}I ranging from 90 to 450 mc. The data were obtained by serial thyroid counting, whole-body counting, and plasma PB ^{131}I levels. A non-linear mathematical model is proposed, consistent with the observed data obtained after the administration of therapy dose. It is found that the turnover rates are variable, the discharge of the iodine from thyroid is proportional to cumulative activity in the thyroid and the rate of iodide uptake by the functioning tumour is proportional to the fractional amount of the functioning tumor. The latter was computed by subtracting from unity the cumulative discharge of iodide from the thyroid. The dose given to the thyroid, the blood and the total body is computed. The results and their significance will be discussed. (auth)

28513 HAIR AS A BIOLOGICAL INDICATOR OF THE ^{226}Ra CONTENT IN MAN. Antonova, V. A.; Shvydko, N. S. (Leningrad Scientific-Research Inst. of Radiation Hygiene). Gig. Sanit.; No. 5, 109-11(May 1971). (In Russian).

Samples of male and female hair, skin tissue, and bone tissue from the skull, femur, breast bone, and rib were analyzed for ^{226}Ra levels. The results showed that the concentration of ^{226}Ra in skeletal tissue was 0.42 times that in hair, when expressed in pCi/kg of material. It was concluded that the assay of ^{226}Ra in the hair can be used to estimate the body burden of that isotope. (K.S.W.)

28514 RADIATION SAFETY IN WORK WITH SUBSTANCES CONTAINING ACTINIUM. Andreeva, O. S.; Malinina, V. I. (Inst. of Biophysics, Moscow). Gig. Sanit.; No. 5, 43-7(May 1971). (In Russian).

The hazards to personnel during work with substances containing actinium are reviewed. Hazards include the inhalation or ingestion of ^{227}Ac, ^{219}Rn gas, or short-lived dissociation daughter products, especially actinium-B (^{211}Pb). Measures for improving the working conditions and reducing the hazards are suggested. (TSS)

28515 DECONTAMINATION OF POLONIUM FROM THE SKIN. Gusarov, I. I.; Khudotenlyi, A. S. (Central Research Inst. of Health and Physical Therapy, Moscow). Gig. Sanit.; No. 5, 94-5(May 1971). (In Russian).

The effectiveness of oxathiol for the removal of ^{210}Po from the skin was compared to that of toilet soap. The data indicate that oxathiol may be successfully used for decontaminating skin which holds adsorbed ^{210}Po. (K.S.W.)

28516 ^{90}Sr DETERMINATION IN HUMAN BONE ASHES. Mimikos, N.; Douvoyiannis, J. (Democritus Nuclear Research Center, Athens). Chem. Chron., Epistem. Ekdosis; 35: No. 1-2, 20-6(1970). (In Greek).

The results of ^{90}Sr determinations in human bones for the period 1965 to 1967 in the Athens (Greece) region were tabulated and compared with the values calculated on the basis of ^{90}Sr contamination of the food. It was found that for 1965 the ^{90}Sr content ranged from 0.23 to 3.55, for 1966 from 0.18 to 5.13, and for 1967 from 0.17 to 3.48 pCi ^{90}Sr/g Ca. The calculated value for 1966 was 1.81 and for 1967 2.34 pCi ^{90}Sr/g Ca. (Euratom)

28517 ESTIMATION OF EFFECTIVE TISSUE THICKNESS IN THE ASSESSMENT OF ^{239}Pu IN LUNG. Shirotani, Takashi; Fujita, Minoru (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 9: No. 3, 165-71(Mar 1972).

For the determination of ^{239}Pu deposited in the lungs by external counting, the absorption of low energy photons emitted from ^{239}Pu in the chest must be taken into consideration because of its high attenuation. It is shown that the effective tissue thickness of the chest wall can be estimated by comparing the Am/Pu counting ratio—which is defined as the ratio of net counting rates between those in the Am-channel (57 to 63 keV) and the Pu-channel (15 to 19 keV)—obtained from an exposed subject with that obtained beforehand as a function of the absorber thickness of a simple chest model. An empirical expression was also derived from experiments on a phantom to estimate the effective tissue thickness. These two methods seem reasonably accurate judging from a comparison with the experimental results obtained by Rundo et al. (auth)

28518 DOSIMETRY OF THE ICRP MODEL FOR THE GASTROINTESTINAL TRACT. Snyder, Walter S. (Oak Ridge National Lab., Tenn.). pp 136-46 of Radiation Dosimetry. Vol. 1. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

A model of the human gastrointestinal tract is described that is

divided into four sections, the stomach, small intestine, upper large intestine, and lower large intestine. Applications of the model for estimations of the radiation dose absorbed during the passage of radioactive materials through the physiologically normal gastrointestinal tract are described. Data from computer calculations of the energy emitted during decay of the radioisotope of interest are used with the model for calculations of the radiation dose as a function of residence time of the radioactive material in each of the four sections and radioactivity leaving the tract by various routes. (C.H.)

28519 DOSIMETRY OF THE ICRP MODEL FOR THE LUNG. Snyder, Walter S. (Oak Ridge National Lab., Tenn.). pp 147-59 of Radiation Dosimetry. Vol. 1. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

A model of the human respiratory tract is described that is divided into three regions, the nasopharynx, the trachea and bronchial tree, and the lungs. Applications of the model for estimations of the radiation dose absorbed following the inhalation of radioactive aerosols are described. The model includes factors for clearance via the blood, the lymphatic system, and the gastrointestinal tract, with deposition varying as a function of aerosol particle size and chemical composition. The radiation dose measurements are based on energy emitted by the radioactive material and daughter products during the residence time in the respiratory tract and clearance routes. (C.H.)

Animals

Refer also to abstracts 28439 and 28440.

28520 (TID-25943) ANNUAL CONSUMPTION OF ^{137}Cs AND ^{60}Co LABELED PINE SEEDS BY SMALL MAMMALS IN AN OAK-HICKORY FOREST. Mathies, John Beatty (Michigan State Univ., East Lansing). 1971. 214p.

Thesis.

Annual and seasonal consumption of eastern white pine seeds was determined in both laboratory and free-ranging populations of small forest mammals using ^{137}Cs and ^{60}Co as tracers. The ratio of body burdens between these two radioisotopes was used to determine food consumption rates for animals trapped in the field. Field equilibria of ^{137}Cs were correlated to laboratory data to estimate seed consumption rates. Of the total pine seed removed from feeders on the field plot, the white-footed mouse population consumed 17% and the short-tailed shrew population accounted for 64%. Results of the experiments indicated that: ^{137}Cs was excreted at a faster rate after injection or single-feeding studies than after chronic feeding; excretion of ^{137}Cs after chronic feeding could not be used to predict chronic uptake adequately in the same animal; radiation-dose estimates would be higher if body burdens after chronic feeding were used rather than body burdens after injection. (H.L.W.)

28521 BIOLOGICAL HALF-LIFE OF TRITIUM IN GOATS. Barth, J.; Stanley, R. E.; Moghissi, A. A. (Western Environmental Research Lab., Las Vegas, Nev.). Health Phys.; 22: No. 4, 396(Apr 1972).

The average biological half-life of ^{3}H in three lactating goats (two Toggenberg and one mixed breed of 70 and 80 kg) was 4 days. The biological half-life after the end of lactation averaged 8 days. Tritiated water (2.5mCi) was administered orally. The biological half-life measured in one non-lactating miniature goat weighing 20 kg and administered 1 mCi was 4.3 days. (UK)

28522 ACCUMULATION OF ^{90}Sr IN PRONGHORN ANTELOPE (ANTILOCAPRA AMERICANA AMERICANA) FEMALES IN ALBERTA. Mitchell, George J.; Hontzeas, Sotirios; Cameron, Wendy (Univ. of Saskatchewan, Regina). Can. J. Zool.; 50: No. 2, 213-16 (Feb 1972).

Radiochemical procedures were used to determine strontium-90 distribution and concentrations in bone samples taken from three positions on the mandibles of female pronghorn antelopes (Antilocapra americana americana) collected in October 1964 in the Newell study area, Alberta. No significant differences in pCi of ^{90}Sr per gram of calcium were found between mandible position means, and females in the same age-classes showed no individual variations in ^{90}Sr burdens. The differences in mean ^{90}Sr concentrations between age-classes were highly significant, with the youngest and oldest animals showing the largest and smallest ^{90}Sr burdens, respectively. (auth)

28523 METABOLISM OF TRITIATED WATER IN THE DAIRY COW. Potter, G. D.; Vattuone, G. M.; McIntyre, D. R. (Univ. of California, Livermore). Health Phys.; 22: No. 4, 405-9(Apr 1972).

Tritium levels were studied in a lactating cow for 71 days after oral administration of 280 mCi of tritiated water. Recovery was studied in milk, urine, feces and blood (plasma and red blood cells). Organically bound tritium concentrations were compared with body water tritium. (UK)

28524 EXPERIMENTAL LUNG CANCERS PRODUCED IN RATS BY INHALATION OF Rn. Chameaud, Jean (CEA, Razes, France); Perraud, Roger; Lafuma, Jacques. Compt. Rend., Ser. D; 273: No. 23, 2388-9(8 Dec 1971). (In French).

Within a period of between 10 and 18 months, inhalation of high concentrations of Rn associated or not associated with U ore dusts produced lung cancers in all the animals exposed. (France)

28525 ^{137}Cs IN PIGEON TISSUES WITH SPECIAL REFERENCE TO MUSCLES. Narayanan, N.; Eapen, Jacob (Bhabha Atomic Research Centre, Trombay, India). pp 609-19 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

The pattern of distribution of ^{137}Cs in pigeon tissues following intramuscular injection changes as a function of time. Over a period of time white muscle shows the highest amount of the radionuclide of all the tissues analyzed. Among the subcellular fractions of cardiac muscle, liver, red muscle, smooth muscle and white muscle, the supernatant had the largest proportion of ^{137}Cs in the order: supernatant > nuclear fraction > mitochondria > microsomes, indicating that the major portion of the radionuclide in cells is not bound to particulate structures. In vivo administration of malonate inhibits and succinate and glucose enhance the uptake of radiocaesium by the muscles of pigeon. (auth)

28526 INFLUENCE OF CARRIER COBALT ON THE DISTRIBUTION AND MOBILIZATION OF ^{60}Co AND ^{60}Co 1-NITROSO 2-NAPHTHOL CHELATE IN ALBINO RATS. Jagadeesan, V.; Sivaramakrishnan, V. M. (Cancer Inst., Madras). pp 621-33 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Cobalt-60, on i.v. administration, has a generalized distribution in the body, concentrating mainly in the liver, skin, bones and muscles before excretion, chiefly through urine. Simultaneous administration of stable cobalt considerably accelerates the metabolism and excretion of cobalt-60, without in any way altering the pattern of distribution. In this way, cobalt differs significantly from iron or zinc. When administered as 1-nitroso 2-naphthol chelate, cobalt-60 accumulates in the liver initially, then moves over to the bones, muscles and skin and is then excreted, mainly through feces. But when carrier cobalt is also added to the chelate, the radioactivity accumulates preferentially in the lungs and not the liver. This may be due to the formation of macroaggregates of the chelate, the particle size determining the tissue of localization. The subcellular distribution of cobalt-60 or cobalt-60 1-nitroso 2-naphthol chelate in the liver is not affected by the simultaneous administration of carrier cobalt. (auth)

28527 RESORPTION OF THORIUM FROM THE GASTROINTESTINAL TRACT BY THE BLOOD AND ITS ACCUMULATION IN ORGANS AND TISSUES OF RATS. Pavlovskaya, N. A.; Provotorov, A. V.; Makeeva, L. G. (Inst. of Hygiene and Occupational Illness, Moscow). Gig. Sanit.; No. 5, 47-50(May 1971). (In Russian).

Experiments carried out on rats showed the resorption of thorium from the gastrointestinal tract by blood and its accumulation in organs and tissues, and especially in bones, to be of variable extent and to depend on the chemical nature of the compounds introduced and condition of nutrition. The concentration of the solutions administered had a certain effect on the extent of resorption. (auth)

28528 DOSE ADMINISTRATION OF RADIOACTIVE AEROSOLS TO DOGS. Matveev, V. I. (Inst. of Biophysics, Moscow). Gig. Sanit.; No. 5, 69-72(May 1971). (In Russian).

A method of administration of a single-dose of aerosol directly into the trachea of dogs is described that employs an apparatus consisting of an aerosol generator, a pure air supply connected with a shunt, valves for regulating the shunted air, a Hg manometer, and an air pressure control for the air supply to the generator. Results are reported from a number of experiments in

which the radiation dose was estimated following the administration of ^{239}Pu in aerosol form to dogs. (K.S.W.)

28529 ANNUAL CONSUMPTION OF ^{137}Cs AND ^{60}Co-LABELED PINE SEEDS BY SMALL MAMMALS IN AN OAK-HICKORY FOREST. Mathies, John Beatty. East Lansing, Mich.; Michigan State Univ. (1971). 235p. University Microfilms Order No. 72-8740.

Thesis.

Annual and seasonal consumption of eastern white pine seeds was determined radioisotopically in both laboratory and free-ranging populations of small forest mammals within a 2-ha oak-hickory forest in eastern Tennessee. White-footed mice were chronically-fed ^{137}Cs and ^{60}Co-labeled pine seeds in the laboratory, and the resultant uptake, equilibrium, and excretion patterns in mice were used to infer food consumption rates. Seed-ingestion rates, of from 2 to 100 seeds per day, were highly correlated with equilibrium levels of ^{137}Cs. Lowering the ambient temperature resulted in lower equilibria, through a range of 21.1 C to 4.4 C; equilibria in males was lower than in female mice. Free-ranging mice rapidly acquired radioactive body burdens of both isotopes. The ratio of the body burdens between these two radioisotopes was used to determine the day of excretion for animals trapped in the field. A laboratory-to-field comparison yielded similar excretion rates of ^{137}Cs, indicating that metabolic stimuli such as temperature or feeding rate did not overtly influence the rate of excretion. Snap-trapped mice from a second chronically-fed field population indicated a similar tissue distribution of ^{137}Cs in mice from both the laboratory and field. Based upon these similarities, a direct correlation was made between the laboratory and field to predict equilibrium levels for mice in the field. Field equilibria of ^{137}Cs were then correlated to the laboratory data to estimate seed consumption rates. Estimates for consumption of this specific food source, by individual white-footed mice, ranged from a maximum of 2.3 g/day in summer, to a minimum of 0.4 g/day in winter. The drop in consumption coincided with availability of the mast crop in autumn. Yearly average consumption of seeds was 1.6 g/day per mouse, or 7.0 kcal/day. Caloric input of this specific food was approximately 50% of the daily food requirement for this species. Survival of the short-tailed shrew was excellent in the field plot, compared to previous studies. On one plot, only 16 shrews died out of a total of 242 captures, with 4 shrews captured at least 12 times; thus allowing reliable estimates of pine seed consumption by this "insectivorous" species. Shrews were twice as numerous as mice and acquired body burdens of radioisotopes equivalent to or greater than those observed in mice. Insects, mice, and seeds were considered as potential food sources for this shrew; however, seed consumption proved to be the source of radioactivity. Individual shrews consumed a maximum of this specific food of 4.1 g/day in autumn, and a minimum of 2.1 g/day in summer. Yearly average consumption of seeds was 3.0 g/day per shrew, or 13.2 kcal/day. Of the total pine seed removed from feeders on the field plot, the white-footed mouse population consumed 17% and the short-tailed shrew population accounted for 64%, or approximately four times the consumptive importance of the granivorous mouse. These two species accounted for 81% of all seeds removed from feeders. It appeared that sufficient seeds would escape detection by these two species, and that the disappearance of white pine in mixed forests, such as these, was not completely due to their consumption of seeds. From a radioecological and health physics aspect, the results from chronic feeding of radioisotopes in a food base indicated: ^{137}Cs was excreted at a faster rate after injection or single-feeding studies than after chronic feeding. Excretion of ^{137}Cs after chronic feeding could not be used to predict chronic uptake adequately in the same animal. Radiation-dose estimates would be higher if body burdens after chronic feeding were used rather than body burdens after injection. Application of this equilibrium technique would be of value in energy flow studies to characterize the total importance of a consumer within an ecosystem. (Diss. Abstr.)

28530 METABOLISM AND TOXICITY OF INHALED ^{144}Ce IN RATS. Thomas, Randi L.; Scott, J. K.; Chiffelle, T. L. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. Radiat. Res.; 49: No. 3, 589-610(Mar 1972).

To aid in assessing the hazard associated with airborne radiocerium, two groups of rats were exposed by inhalation to heat-treated ^{144}Ce hydroxide aerosols resulting in body burdens of about 3.0 (0.85 to 6.6) or about 170 (79 to 300) μCi ^{144}Ce/kg body weight. Following initial rapid clearance, the ^{144}Ce had an effective half-time of 130 days in lung. Based on average kinetics of whole-body and lung retention, estimated cumulative β-radiation doses to lungs of the high-level rats were 620 rads at 100 days, 1000 rads at 300 days, and 1150 rads at 600 days postinhalation exposure, per μCi initial lung burden. Estimated cumulative doses to lungs to time of death averaged 5100 rads and ranged from 2400 to 8800 rads. Other organs of interest, for which β-radiation doses were calculated, were skeleton, liver, and tracheobronchial lymph nodes. Cerium-144 also concentrated significantly in kidneys. Median survival times were 135 and 393 days postexposure for the high-level and low-level rats, respectively. Radiation fibrosis of lungs was noted in 16 of 20 high-level rats that died 101 to 607 days postexposure. Five of 14 rats that died 263 to 607 days postexposure had squamous cell carcinomas of lung, two cases having metastases to other organs. No radiation-induced changes were observed in the low-level rats. (auth)

Plants

Refer also to abstract 28376.

28531 (CONF-711213-1) TRANSFER OF ^{137}Cs FROM DETRITUS TO PRIMARY PRODUCER. Witkamp, M. (Oak Ridge National Lab., Tenn.). [nd]. 12p. Dep. NTIS.

From Symposium on the use of isotopes and radiation in research on soil-plant relationships including applications in forestry; Vienna, Austria (13 Dec 1971).

A combination of radiotracer, microcosm, and systems analysis techniques was used in evaluating recycling of minerals from detritus back to the vegetation. A greenhouse experiment with microcosms of increasing complexity showed the effects of millipedes and snails on ^{137}Cs movement from leaf litter to tree seedlings. Millipedes increased the organic matter content of the soil and the concentration and availability of ^{137}Cs. The increase in growth and mineral uptake by plants suggests that millipedes affect both nutrient and ^{137}Cs kinetics in similar ways. With snails there were smaller increases in ^{137}Cs turnover in soil and less tree growth than with millipedes. Snails also reduced plant growth by consuming part of the foliage. Gross transfer coefficients for movement of ^{137}Cs from detritus to plants were determined through analysis of ^{137}Cs turnover using a simulation model. (auth)

28532 EFFECT OF CALCIUM LEVELS ON REDISTRIBUTION OF ^{85}Sr IN BUSH BEAN PLANTS. Wallace, Arthur (Univ. of California, Riverside, Univ. of California, Los Angeles). Plant Soil; 35: 415-20(1971).

When bush bean plants previously exposed to ^{85}Sr were transferred to solutions containing different levels of calcium without further addition of ^{85}Sr, the calcium had relatively little, but some, effect on the redistribution of the ^{85}Sr in the plants. Calcium did tend to restrict movement of strontium, and ^{85}Sr tended to concentrate in stems or old leaves, usually more so than calcium. New leaves particularly had lower Sr/Ca ratios than other plant parts, indicating some discrimination in favor of calcium. (auth)

28533 ^{210}Pb AND ^{210}Po CONTENTS IN SOME CZECHOSLOVAK CIGARETTES. Solnicka, H.; Bischof, R. (Inst. of Occupational Hygiene in Uranium Industry, Pribram, Czech.). Cas. Lek. Cesk.; 109: No. 28, 654(26 Jun 1970). (In Czech).

When considering the problem of internal contamination by ^{210}Pb and ^{210}Po in uranium miners, a possible intake of these radionuclides from other sources had to be checked. Lead-210 amounts (pCi per one cigarette) in various kinds were as follows: Sparta 0.49, Letka 0.28, Lipa 0.41, Start 0.37, and Partyzánka 0.36; the respective values of ^{210}Po were as follows: 0.45, 0.22, 0.22, 0.19, 0.00, and 0.40. Differences between the respective kinds of cigarettes were insignificant. Lead-210 and ^{210}Po contents are in an approximate radioactive equilibrium. The content of radionuclides in question in Czechoslovak cigarettes is comparable to that in foreign products. (NSA of Czech)

Microorganisms

28534 (EUR-4763) TRANSPORT OF RADIONUCLIDES BY THE SUBCELLULAR STRUCTURES OF LIVING CELLS. Annual Report, 1970. (Louvain Univ. (Belgium). Laboratoire d'Enzymologie). 1972. 14p. (In French). Dep. NTIS (U. S. Sales Only). EUR FB 25,-.

Research was carried out on the following: transport of radionuclides by whole cells using the yeast Schizosaccharomyces pombe as the model cell; transport of radionuclides (Ca^{++}) by isolated chloroplasts; perfection of techniques to isolate intact mitochondria with a view to study the transport radionuclides by isolated mitochondria; and study of the toxicity mechanism of dithiocarbamates (for example, of ziram: bis(dimethyl dithiocarbamate) zinc, in Saccharomyces cerevisiae). (auth)

New Tracer Techniques

Refer also to abstracts 27798 and 28440.

MATERIALS

Ceramics and Cermets

Refer also to abstracts 27863, 27950, 27973, 27974, 27998, 28101, 28102, 28270, 28608, 28610, 28667–28672, 30092, 30101–30103, and 30224.

28535 (ANL–7775, pp 64-86) MATERIALS CHEMISTRY AND THERMODYNAMICS. Tevebaugh, A. D. (Argonne National Lab., Ill.). Apr 1971.

In Chemical Engineering Division annual report, 1970.

Research progress is reported on high-temperature thermodynamics of fuels, reactor safety and physical properties of reactor materials and fuels, and calorimetry of compounds used in reactors. (J.R.D.)

28536 (ANL/EBR–51) PREIRRADIATION CHARACTERIZATION OF B_4C PELLETS USED IN EXPERIMENTS ON HIGH-WORTH CONTROL RODS. EBR-II Project. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Jan 1972. Contract W-31-109-eng-38. 21p. Dep. NTIS.

Approximately 250 natural-boron B_4C pellets were procured for use in EBR-II. The preirradiation properties of this material such as the density, the boron-to-carbon mole ratio, the total boron and carbon assay, the purity, and microstructure are reported. In addition, a very unusual and essentially anomalous density gradient for the pellets, determined by 20-kV x-radiography, was evaluated. (auth)

28537 (BLG–460, pp 3,48-64) EXPLORATORY RESEARCH. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 1970. 17p.

In Annual scientific report, 1970.

BELGIAN REACTOR-2—power density distribution in, measurement by nitrogen-16 production in fuel channels
BELGIAN REACTOR-3—neutron flux measurements in, activation monitors for
EXPONENTIAL PILES—lattice parameter determination in water-moderated uranium-235, moments method for
LANTHANUM NITRIDES—preparation and properties of LaN
LITHIUM-6—neutron reactions (n,α), use in measuring fast neutron spectra
MATHEMATICAL PHYSICS—iterative solution of neutron diffusion multigroup equations
NEUTRONS—diffusion calculations for, iterative solution for multigroup equations for
NEUTRONS, FAST—spectra of, measurement using lithium-6, reactions
—detection by recovery time measurements for irradiated PIN-type diodes
OXYGEN SYSTEMS—O–Th–W, phase diagrams of, at high temperatures
PLUTONIUM—separation from ruthenium-106 and zirconium-95 by ion exchange
RADIATION DETECTORS, ACTIVATION—development for neutron measurements at 10 to 15 MeV
—development for in-pile neutron flux and spectra measurements
RADIATION DETECTORS, PROPORTIONAL—development of proton–recoil, for fast neutron spectroscopy
RUTHENIUM-106—separation from plutonium by ion exchange
ZIRCONIUM-95—separation from plutonium by ion exchange
(J.R.D.)

28538 (BMI–1705) MECHANISM OF URANIUM FORMATION BETWEEN URANIUM CARBIDE AND NIOBIUM. Getz, Ralph W.; Moak, Donald P.; Chubb, Walston; Keller, Donald L. (Battelle Memorial Inst., Columbus, Ohio). 1 Dec 1964. Contract W-7405-eng-92. 41p. Dep. NTIS.

Declassified 29 Oct 1971.

The formation of liquid uranium between niobium and uranium carbide above 1130°C is explained in terms of diffusional processes near the interface. Two cases are recognized: (1) liquid formation when the carbon in the UC reacts with niobium, driving the composition of the bulk of the UC below stoichiometry; and (2) liquid formation while the bulk of the UC contains an excess of carbon. Case (1) can occur when a continuous, thin duplex layer of NbC plus Nb_2C, a layer not in the natural sequence of layers, is inserted between niobium and UC. In Case (2) multicomponent diffusion concepts are required to explain the behavior. It is postulated that the three components, uranium niobium, and carbon, interdiffuse initially in the solid state, and a two-phase reaction zone of Nb_2C and (Nb,U) alloy is formed because there is a difference in solubility of uranium in Nb_2C and in (Nb,U) alloy. A liquid (U,Nb) phase nucleates at or near the UC–(Nb,U) alloy interface when uranium concentration in the (Nb,U) alloy becomes greater than that of the solidus composition at any particular temperature. Clean niobium and UC surfaces, and cold-worked niobium were found to favor formation of a liquid phase by multicomponent diffusion. In the study of liquid formation it was found that variations in carbon content of the fuel had no significant effect but that zirconium and uranium additions to the cladding increased the tendency for liquid formation. (auth)

28539 (BMI–1923) PROGRESS ON DEVELOPMENT OF FUELS AND TECHNOLOGY FOR ADVANCED REACTORS DURING OCTOBER THROUGH DECEMBER, 1971. Quarterly Report. Keller, Donald L. (Battelle Columbus Labs., Ohio). Jan 1972. Contract W-7405-eng-92. 77p. Dep. NTIS.

Research and development progress is reported on PUN–UN fuels for LMFBR, nuclear fuels for advanced fast reactors, and creep of reactor fuel materials. (J.R.D.)

28540 (EUR–4756) PROPERTIES OF SINGLE REFRACTORY OXIDES. Ferrero, G. L. (European Atomic Energy Community, Petten (Netherlands). Joint Nuclear Research Center). 1972. 42p. (In French). Dep. NTIS (U. S. Sales Only). EUR FB 60,-.

Physical, chemical, thermal, and mechanical properties are given together with temperature-dependent details applicable to materials which can be used for the construction of high-temperature irradiation rigs. The data are arranged to provide easy comparisons in the selection of materials. The data for single refractory oxides are arbitrarily limited to those that are commercially available. (165 references) (auth)

28541 (HEDL-TME–71-191) EVALUATION OF CARBIDE VENDOR PREQUALIFICATION PELLETS. Final Report. Barr, M. J. (Hanford Engineering Development Lab., Richland, Wash.). Nov 1971. Contract AT(45-1)-2170. 44p. Dep. NTIS.

A boron carbide vendor prequalification program was undertaken to evaluate the capability of industry to produce boron carbide pellets to a provisional FFTF specification and to provide a technical base from which a formal boron carbide pellet specification could be written. Three potential vendors' products were evaluated with none of the three meeting every requirement of the provisional specification. Problem areas or deficiencies are identified and discussed. Data obtained from this evaluation have been incorporated into RDT Standard E 6-30T, Absorber Pin Boron Carbide Pellet. (auth)

28542 (NAA-SR–126) CORROSION OF REFRACTORY MATERIALS IN SODIUM. Loftness, R. L.; Ruebsamen, W. C.; Coultas, T. A. (North American Aviation, Inc., Downey, Calif.). 20 Nov 1951. Contract AT-40-1-GEN-1064. 42p. Dep. NTIS.

Declassified 22 Oct 1971.

The corrosion of refractory materials in liquid sodium and sodium vapor at 900°C for periods of time up to 1 month was studied under static conditions. Vacuum-distilled sodium was used in all but a few instances. Changes in weight, appearance, and metallographic structure were observed, and post-run chemical analyses of the sodium were made. In general the rates of corrosion were higher in liquid sodium than in sodium vapor. The presence of excessive oxygen in the sodium increased the corrosion rates. In order of decreasing resistance to corrosion by sodium at 900°C the materials are: molybdenum, tungsten, Haynes Stellite-25, type 347 stainless steel, Kennametal-138A, tantalum, and titanium. Graphite, copper, platinum, spinel, alumina, magnesia, and zirconia showed poor resistance. Silicon carbide, molybdenum silicide, and thoria showed good resistance to corrosion. Synthetic sapphire and single-crystal magnesia had good resistance. (auth)

28543 (ORNL–4773) COMPATIBILITY OF CURIUM OXIDE WITH REFRACTORY METALS AT 1650°C AND 1850°C. DiStefano, J. R.; Lin, K. H. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 43p. Dep. NTIS.

The power density of $^{244}Cm_2O_3$ makes it an attractive fuel form for a variety of radioisotopic applications. To evaluate the compatibility of $^{244}Cm_2O_3$ with various refractory metals for high-temperature applications, tests were made on Ta, Ta–10% W,

T-111, Mo, TZM, W, and W–26% Re at 1650 and 1850°C for times up to 10,000 h. Serious reactions between $^{244}Cm_2O_3$ and Ta–10% W and T-111 were found at 1650°C. With Mo, TZM, W, and W–26% Re only limited attack occurred, mainly in the form of intergranular subsurface voids. At 1850°C there was evidence of dissolution of tantalum and the tantalum alloys by $^{244}Cm_2O_3$. After 5,000 and 10,000 h tantalum had transferred from one portion of the capsule to another, and tantalum particles were found in the fuel. Less extensive mass transfer was noted with the other materials, although significant amounts of tungsten from the unalloyed tungsten and W–26% Re tests were found in the fuel. It was concluded that W–26% Re, TZM, and molybdenum exhibited the best compatibility with $^{244}Cm_2O_3$ under the test conditions. The influence of temperature gradients on mass transport reactions and greatly increased $^{244}Cm_2O_3$-to-metal surface area or weight ratios should be investigated in future tests. (auth)

28544 (ORNL–TM–3640) IRRADIATION TEST OF BONDED HTGR COATED PARTICLE FUELS IN AN INSTRUMENTED CAPSULE IN HFIR. Scott, J. L.; Conlin, J. A.; Coobs, J. H.; Hewette II, D. M.; Robbins, J. M.; Senn, R. L.; Montgomery, B. H. (Oak Ridge National Lab., Tenn.). Mar 1972. Contract W-7405-eng-26. 36p. Dep. NTIS.

Fuel elements proposed for HTGR's consist of hexagonal blocks of graphite with parallel fuel and coolant channels. The coated particles of fuel and fertile materials are bonded with a carbonaceous matrix to form fuel sticks, which are then loaded into the fuel channels. An experiment was conducted to study the interaction of the particle coatings, bonding matrix, and graphite block during irradiation. The instrumented and swept capsule contained a graphite sleeve that supported specimens of coated particles bonded with both low- and high-density matrices. The capsule, HRB-1, was irradiated in the removable beryllium facility of HFIR for 186 days at fuel temperatures of 1000 to 1250°C. The peak burnup achieved was 22 at. % in coated UO_2 particles, and the maximum fast fluence was 5.8×10^{21} neutrons/cm^2 (>0.18 MeV). The fission gas release rates were moderate and increased slightly after about 120 days. After irradiation, the specimens bonded with phenolic resin (low-density matrix) debonded and crumbled easily, while samples that had been bonded with high-density matrices were intact. The fracture of some outer carbon coatings on TRISO-coated fuel particles was attributed to densification and interaction of the coating layers. No fuel particles with completely failed coatings were found. These results indicate the need for certain changes in coating design and binder designations and suggest that fuel sticks bonded with high-density matrices can be expected to retain integrity after full HTGR exposure of about 8×10^{21} neutrons/cm^2 (>0.18 MeV). (auth)

28545 (ORO–4212-11) QUANTITATIVE DETERMINATION OF THE STRUCTURE–PROPERTY RELATIONSHIPS IN NUCLEAR FUEL ELEMENT MATERIALS. Annual Progress Report, June 15, 1971–March 15, 1972. Rhines, F. N.; DeHoff, R. T.; Whitney, E. D. (Florida Univ., Gainesville. Engineering and Industrial Experiment Station). Contract AT(40-1)-4212. 77p. Dep. NTIS.

The range of available microstructural states in both UO_2 and nickel sinterings has been significantly increased by the fabrication and acquisition of hot pressing equipment, as well as by progress in separating fractions of the as-received powder. Results of microstructural characterization in terms of averages of the metric properties, volume fraction, surface area, and total curvature indicate that the microstructural states thus far obtained generally fall nominally within the range of those observed for other equiaxed powders. UO_2 structures prepared by cold pressing deviate from this sintering behavior because the effects of cold pressing were not removed by subsequent treatments. Property measurements made on characterized microstructures have yielded empirical quantitative correlations for gas permeability and tensile strength of porous nickel. Relations between properties of fracture surfaces and mechanical behavior have also been evolved. The determination of variation of thermal conductivity with structure for one series of samples has demonstrated that modifications of the thermal conductivity apparatus to allow atmosphere control have been successful. The analysis of creep in nickel sinterings has been greatly facilitated by the observation of simple relationships between creep rate and time under load. The reduction of the data to a description in terms of three empirical constants will make tractable correlations between structure, load, and temperature which would be too complex to deduce from the raw data. (auth)

28546 (SC-DR–720055) PLASTICITY AND CREEP ANALYSIS OF FILAMENTARY METAL–MATRIX COMPOSITES. Bert, C. W. (Sandia Labs., Albuquerque, N. Mex.). Mar 1972. 47p. Dep. NTIS.

A unified method of analyzing the time-independent plastic deformation and creep behavior of filamentary composites is described. The approach used is that of engineering plasticity, rather than rigorous mathematical theory. The validity of the approach is verified by comparison with test data on unidirectional metal-matrix composites from the literature as well as unpublished Sandia Laboratories data. The composites used for these cases are beryllium/aluminum (relatively ductile fibers and matrix) and boron/aluminum (brittle elastic fibers and ductile matrix). Composite behavior information predicted from constituent information includes: longitudinal stress-strain curve, longitudinal strength, major transverse-contraction ratio vs. stress, transverse stress-strain curve, and transverse strength. The analyses were also extended to indicate simple preliminary design formulas for quasi-isotropic laminates subjected to balanced biaxial tension, for which no test data appear to be available at present for metal-matrix composites. Since reliable creep data for the constituent materials in the temperature range of interest are not yet available, the creep results are based on estimated constituent properties and must be considered as merely sample calculations. (auth)

28547 (WARD–4210-T-3-3) OXIDE FUEL ELEMENT DEVELOPMENT. Quarterly Progress Report for the Period Ending March 31, 1971. Anderson, C. A. Jr.; Bishop, E. C.; Boltax, A.; Ray, W. E. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Jun 1971. Contract AT(30-1)-4210. 185p. Dep. NTIS.

Results of parallel analytical and experimental studies on mixed oxide fuel pins are reported. Research progress is reported on fuel performance, fuel analytical methods, radiation testing of fuels, development of grid-type fuel elements, development of LMFBR fuel assemblies, development of EBR-II fuel assemblies, subassembly design, pellet fabrication, and oxide fuel evaluation. (J.R.D.)

28548 (WARD–4210-T-3-8) OXIDE FUEL ELEMENT DEVELOPMENT QUARTERLY PROGRESS REPORT FOR THE PERIOD ENDING JUNE 30, 1971. Anderson, C. A. Jr.; Bishop, E. C.; Boltax, A.; Ray, W. E. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Contract AT(30-1)-4210. 150p. Dep. NTIS.

Research on fuels is reported related to radiation effects on fuel-cladding interactions and fuel swelling. Results are also included on oxide fuel pin irradiation tests, irradiation tests on grid-type subassemblies, design and fabrication of grid-type subassemblies, fabrication of PuO_2–UO_2 pellets, and fuel evaluation programs. (J.R.D.)

28549 EFFECT OF HEAT-TREATMENT TEMPERATURE ON THERMAL CONDUCTIVITY AND ELECTRICAL RESISTIVITY OF PYROGRAPHITE. Chekhovskoi, V. Ya.; Petrov, V. A.; Petrova, I. I. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 4, 771-3(Jul-Aug 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 4, 851-4(Jul-Aug 1971).

Pyrographite (pyrolytic graphite) obtained from methane at 2100°C was subjected to heat treatment in an argon atmosphere in a resistance furnace with a graphite heater for 3 h at 2600°C, 2 h at 2900°C, or 1 h at 3100°C. The results of an x-ray structural analysis of heat-treated specimens showed that an increase in the heat-treatment temperature increased the size of the crystallites, reduced the interlayer spacing, and reduced the line halfwidth, which is an index of the order of the crystallites in the layer, i.e., an increase in heat-treatment temperature improves the crystalline structure of pyrographite. It was also found that thermal conductivity decreased up to temperatures of about 1600 to 1880°K and then increased at higher temperatures. An increase in heat-treatment temperature lowered absolute values of the electric resistivity and shifted the resistivity minimum towards lower temperatures. The pyrographite became more like single-crystal graphite. (P.C.H.)

28550 INVESTIGATIONS ON THE SYSTEM BORON–CARBON–SILICON. Kieffer, R.; Gugel, E.; Leimer, G.; Ettmayer, P. (Technische Hochschule, Vienna). Ber. Deut. Keram. Ges.; 47: No. 2, 41-6(Feb 1972). (In German).

The elements B, C, and S binary compounds form with each other which are very interesting from the point of view of their structure and their chemistry and which are important for technology. The behavior of the binary compounds occurring in the three-component system was studied. Investigations employing various techniques, such as x-ray, chemical analysis, micros-

copy, and fusion experiments showed that no ternary phase exists within the boundary of the ternary system. There was no compound with a higher abrasion capacity than boron carbide. The probable phase field divisions at two isothermic intersections and the fusion isotherms are indicated. (auth)

28551 THERMAL PHASE EQUILIBRIA IN THE $SrO–V_2O_5$ SYSTEM. Solacolu, S.; Dinescu, R.; Zaharescu, Maria (Institut fuer Physikalische Chemie, Bucharest). Rev. Roum. Chim.; 17: No. 1-2, 311-17(Jan-Feb 1972). (In German).

A thermal phase equilibrium diagram of the binary system $SrO–V_2O_5$ was prepared. Three binary compounds: $SrO \cdot V_2O_5$, $2\,SrO \cdot V_2O_5$, and $3\,SrO \cdot V_2O_5$ which melted congruently at 658°C and showed incongruent phases at 1010 to 1250°C were found. The investigation was conducted using radiographic, light microscopic, and IR spectroscopic methods. (tr-auth)

28552 NONSTOICHIOMETRY OF NUCLEAR FUEL MATERIAL. STRUCTURE AND THERMODYNAMICS. Saito, Yasutoshi (Akita Univ., Japan). Nippon Kinzoku Gakkai Kaiho; 10: No. 10-11, 641-52; 742-50(Oct 1971). (In Japanese).

An outline of the nonstoichiometric phase relationship of ceramic fuel material is presented along with an explanation of structure and thermodynamics of uranium dioxide. The ceramic fuel material comprises the uranium dioxide $UO_{2\pm x}$, plutonium dioxide PuO_{2-x}, mixed oxide of uranium and plutonium $(U,Pu)O_{2\pm x}$, carbide of uranium and plutonium, and oxide and carbide of thorium. (Japan)

28553 INVESTIGATIONS ON THE $LaCo_5$–H AND $CeCo_5$–H SYSTEMS. Kuijpers, F. A. (Philips Research Labs., Eindhoven, Netherlands). J. Less-Common Metals; 27: No. 1, 27-34(Apr 1972).

Pressure-composition isotherms and results of x-ray and magnetization measurements are presented for the pseudobinary systems $CeCo_5$–H and $LaCo_5$–H. In the latter system two orthorhombic hydrides were formed with hydrogen contents of ≈3.35 (β hydride) and ≈4.3 (γ hydride). From ln p vs 1/T plots the heat of formation of the hydrides was derived: −10.8 and −7.7 kcal/mole H_2, respectively. In the $CeCo_5$–H system one orthorhombic (β) hydride was observed with a hydrogen content not exceeding $3H/CeCo_5$. At room temperature the primary hydrogen solubility in the hexagonal $CeCo_5$ phase was relatively large. Magnetization measurements ($\sigma_{||}$ – T) were performed on aligned powder specimens. The magnetization of $CeCo_5$ decreased only moderately (≈20%) due to the absorption of $2.2H/CeCo_5$. The The $\sigma_{||}$ – T curves of the two $LaCo_5$ hydrides are quite different, the β hydride being much more strongly dependent on temperature than the γ hydride (in the temperature range 4 to 320 K). From an extrapolation of the $\sigma_{||}$ curves the Co moments at 0 K were determined: 1.14 μ_B in the β hydride and 0.34 μ_B in the γ hydride (1.44 μ_B in $LaCo_5$). (auth)

28554 CRYSTAL GROWTH OF TmB_2 AND ErB_2. Castellano, R. N. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Mater. Res. Bull.; 7: No. 4, 261-5(Apr 1972).

Single crystal platelets of thulium diboride and erbium diboride having an area of 1 mm^2 on major growth facets have been grown out of a molten rare earth flux at 1750°C using an rf induction furnace. These diborides were found to be hexagonal in structure as determined by x-ray diffraction analysis of single crystals using a modified Debye–Scherrer technique. (auth)

28555 PREPARATION AND LATTICE PARAMETERS OF THE RARE EARTH TETRABORIDES. Fisk, Z.; Cooper, A. S.; Schmidt, P. H.; Castellano, R. N. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Mater. Res. Bull.; 7: No. 4, 285-8(Apr 1972).

Single crystals of the rare-earth tetraborides up to 1 mm in length have been grown from a molten metal flux using an rf induction furnace. Results of lattice parameter measurements are presented. (auth)

28556 EFFECTS OF KCl AND NaCl ADDITIONS ON CERTAIN PHYSICAL PROPERTIES OF CsCl. Fullam, H. T. (Battelle-Northwest, Richland, Wash.). Mater. Res. Bull.; 7: No. 4, 289-300(Apr 1972).

The effects of KCl and NaCl additions on the melting point, solid phase transition, and thermal expansion of CsCl were examined. The CsCl solid phase transition was observed in samples containing as little as 10 wt % CsCl. The addition of KCl or KCl + NaCl lowered the temperature at which the phase transition began as much as 170°C. (auth)

28557 GAS CHROMATOGRAPHIC DETERMINATION OF REVERSIBLE ADSORPTION OF HYDROGEN. XI. REVERSIBLE ADSORPTION OF HYDROGEN OVER SOME METAL OXIDES. Shigehara, Yoshiko; Ozaki, Atsumu (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap.; 45: No. 2, 634-5(Feb 1972).

The reversible adsorption of hydrogen was measured over some hardly reducible oxides, such as Cr_2O_3, V_2O_3, MnO, and ZnO, at high temperatures. The procedure involved the introduction of a deuterium sample into the hydrogen carrier gas by means of a doser made of glass tubing and then passed to the catalyst column and detector. Retention volumes over V, Mn, and Zn oxides were commonly null near room temperature, but increased above about 100°C up to respective maximums. The extent of conversion of D_2 into HD began to increase and reached isotopic equilibrium at a much lower temperature than the retention volume, particularly in the case of ZnO, where the conversion was 100% below 0°C. The results for MnO suggest that the exchange reaction between H_2 and D_2 is catalyzed by an active site other than the adsorption site for high temperature adsorption. (P.C.H.)

28558 PHASE DIAGRAM FOR THE SYSTEM V_2O_5–ZnO. Makarov, V. A.; Fotiev, A. A.; Serebryakova, L. N. Zh. Neorg. Khim.; 16: No. 10, 2849-52(Oct 1971). (In Russian).

A study was made of the phase compositions existing in the V_2O_5– ZnO system. In addition to the compounds ZnV_2O_6, $Zn_2V_2O_7$, and $Zn_3V_2O_8$ already known, the presence of $Zn_4V_2O_9$ was established. Microscopic and thermal properties of individual phases were investigated and the usual phase diagram was constructed. (tr-auth)

28559 CHEMICAL STABILITY AND ANALYSIS OF METALLIC DODECARBORIDES WITH THE UB_{12} STRUCTURE. Yukhimenko, E. V.; Odintsov, V. V.; Kotlyar, E. E.; Paderno, Yu. B. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 11, 895-7(Nov 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 11, 52-5(Nov 1971).

A study was made of the chemical stability of dodecaborides of the rare-earth metals of the yttrium subgroup, and also of zirconium and uranium, in acids and their mixtures. It was established that the stability of the dodecaborides is higher than that of other boride phases of the corresponding metals; all the dodecaborides investigated resist attack by hydrochloric and sulfuric acids and are decomposed only by oxidizing acids. Yttrium and ytterbium dodecaborides exhibit higher resistance to attack compared with the other phases. A method is proposed for the chemical analysis of dodecaborides. (auth)

28560 EFFECT OF SHOCK WAVES ON REFRACTORY COMPOUNDS. II. TiB_2, ZrB_2, W_2B_5, $TiSi_2$, $ZrSi_2$, $MoSi_2$, TiC, ZrC, NbC, AND WC. Adadurov, G. A.; Breusov, O. N.; Dremin, A. N.; Tatsii, V. F. (Inst. of New Chemical Problems, Moscow. Inst. of Chemical Physics, Moscow). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 11, 859-61(Nov 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 11, 7-9(Nov 1971).

Results of investigations showed that the refractory borides, silicides, and carbides of the transition metals are capable of withstanding the action of strong waves, although some of them (tungsten carbide and, possibly, niobium and zirconium carbides) undergo a partial, readily reversible decomposition. The residual defects generated in materials by the passage of shock waves are not annealed out under the action of the residual temperatures of shock compression. Since such defects activate the crystal lattices of these materials, they may be utilized for lowering sintering temperatures and increasing the density of sintered parts. (auth)

28561 HOT PRESSING OF OXIDES OF REFRACTORY METALS. Fen, E. K. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 11, 871-3 (Nov 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 11, 22-5(Nov 1971).

A study was made of the sintering process in the hot pressing of several powdered oxides of transition metals such as TiO_2, ZrO_2, V_2O_5, Nb_2O_5, and Cr_2O_3. It was established that, at any given treatment duration, raising the temperature steadily increases the rate of densification and density of specimens. At each temperature, the densification process is characterized by a specific final density. (auth)

28562 STRUCTURE AND PROPERTIES OF ZIRCONIUM DIBORIDE–TUNGSTEN ALLOYS. Kuzenkova, M. A.; Kislyi, P. S.; Zaverukha, O. V.; Kuz'ma, Yu. B. (Inst. of Materials

Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 11, 879-83(Nov 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 11, 32-7(Nov 1971).

A study was made of the preparation and structure of ZrB_2–W cermets containing 0 to 50% W. Data and information are included on dilatometry, electric conductivity, microstructure, and lattice constants, and tensile properties. (J.R.D.)

28563 THERMODYNAMIC PROPERTIES OF REFRACTORY CARBIDES IN THE TEMPERATURE RANGE 0 TO 3000°K. II. NIOBIUM CARBIDE. Turchanin, A. G.; Guseva, E. A.; Fesenko, V. V. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 11, 890-1(Nov 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 11, 45-7(Nov 1971).

The thermodynamic properties of niobium carbide were investigated at 0 to 3000°K. Resulting data are presented tabularly and compared with previously obtained results. (J.R.D.)

28564 PHASE EQUILIBRIA IN THE SYSTEMS MOLYBDENUM–MANGANESE–CARBON AND TUNGSTEN–MANGANESE–CARBON. Telegus, V. S.; Kuz'ma, Yu. B.; Marko, M. A. (Lvov State Univ.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 11, 898-903(Nov 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 11, 56-63(Nov 1971).

Experimental results are presented graphically. It was found that no series of solid solutions occurs in these systems, but ternary compounds are formed. Other interpretative comments on the data are included. (J.R.D.)

28565 EFFECT OF DYSPROSIUM OXIDE ON THE PROPERTIES OF NICKEL–ZINC FERRITES. Gorbatyuk, V. A.; Tsybanenko, L. N. (Kiev Engineering Inst.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 11, 904-8(Nov 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 11, 64-8(Nov 1971).

The effects of Dy on magnetic permeability, specific magnetization, x-ray diffraction, lattice constants, and microstructure of Ni–Zn ferrites were investigated. The resulting data are presented and discussed. (J.R.D.)

28566 HIGH-TEMPERATURE REACTIONS OF ZrO_2 AND MgO WITH $MoSi_2$ AND ZrB_2. Gropyanov, V. M.; Yudin, B. F.; Chistyakova, M. V.; Kozlovskii, L. V.; Serbezova, R. Ya. (Leningrad Technological Inst.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 11, 916-20(Nov 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 11, 78-83(Nov 1971).

Results of sintering of mixed powders in the systems MgO–$MoSi_2$, $MoSi_2$–ZrO_2, MgO–ZrB_2, and ZrO_2–ZrB_2 are presented and discussed. (J.R.D.)

28567 CONSTITUTION DIAGRAM OF THE SYSTEM TANTALUM–BORON. Portnoi, K. I.; Romashov, V. M.; Salibekov, S. E. (All-Union Scientific-Research Inst. of Aviation Materials, Moscow). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 11, 925-7(Nov 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 11, 89-91(Nov 1971).

Preparation of an accurate phase diagram of the Ta–B system based on thermal analysis data is described. The compounds in the system were also studied using x-ray diffraction and metallographic methods. Supporting data were obtained by electron probe microanalysis and microhardness measurements. (J.R.D.)

28568 EVALUATION OF THE EFFECT OF RARE-EARTH IONS ON THE PROPERTIES OF MAGNESIUM FERRITE. Samsonov, G. V.; Lukach, P. (Inst. of Materials Science, Kiev. Kiev Engineering Inst.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 11, 934-7(Nov 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 11, 99-103(Nov 1971).

Analysis of geometric and energetic factors shows that a partial replacement of the Mg^{2+} ions by rare earth metals (REM) ions is possible, but is hindered mainly by the high thermal stability of MgO. A partial replacement of the Fe^{3+} ions by REM ions is also possible. It may be assumed that REM cations will occupy preferentially the octahedral positions. REM cations entering the ferrite lattice would be expected to alter the conditions of indirect exchange reaction and the overall magnetic moment of the ferrite, thereby strongly affecting the magnetic characteristics of the material. The electrical resistivity of magnesium ferrite alloyed with REM ions varies depending on the positions occupied in the lattice by valency electrons released from linkage. (auth)

28569 PHASE DIAGRAM OF THE SYSTEM Sm_2O_3–SrO. Tresvyatskii, S. G.; Lopato, L. M.; Kushchevskii, A. E.; Shevchenko, A. V. (Inst. of Problems in Materials Science, Kiev). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 10, 1681-2(Oct 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 10, 1880-1(Oct 1971).

Phase ratios in the system Sm_2O_3–SrO were studied in the range 1300 to 2400°C using both static and dynamic methods of physicochemical analysis. The phase diagram of the system Sm_2O_3–SrO was constructed from the experimental data. The diagram was characterized by the presence of 2:1 ($SrSm_2O_4$) and 1:1 ($SrSm_2O_4$) compounds, the existence of solid solutions based on the initial oxides, and by a decrease in the polymorphic-transition temperatures of the B-, A-, H-, and X-forms of Sm_2O_3 when SrO is added. The 1:1 compound was stable throughout the range of investigated temperatures from 1300°C to t_m = 2090°C. Solid solutions based on strontium oxide and the low-temperature B-form of Sm_2O_3 were studied by the annealing and quenching method. The maximal solubility of SrO in the B-form of Sm_2O_3 was 6.5 mole % (1460°C); at 1300°C it was only 2.5 mole %. (P.C.H.)

28570 ENTHALPY AND HEAT CAPACITY OF Ho_2O_3 AT HIGH TEMPERATURES. Tsagareishvili, D. Sh.; Gvelesiani, G. G. (Inst. of Metallurgy, Tbilisi, USSR). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 10, 1679-80(Oct 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 10, 1878-9(Oct 1971).

The enthalpy of the C-form (cubic modification) of Ho_2O_3 was determined by the method of mixing in a massive calorimeter with an isothermal jacket (298.0 ± 0.01°K). The semigraphical method in the range 298.15 to 1620.9°K was used to derive interpolation equations of the temperature dependences of the enthalpy $H_T - H_{298.15}$ and the true heat capacity C_p of Ho_2O_3. Data are tabulated. (P.C.H.)

28571 PHASE DIAGRAMS OF THE SYSTEMS Y_2O_3–SrO AND Yb_2O_3–SrO. Tresvyatskii, S. G.; Lopato, L. M.; Kushchevskii, A. E.; Shevchenko, A. V. (Inst. of Problems in Materials Science, Kiev). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 10, 1614-17(Oct 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 10, 1808-11(Oct 1971).

Phase diagrams were constructed for the systems Y_2O_3–SrO and Yb_2O_3–SrO in the range 1500 to 2430°C. The compounds SrY_2O_4, $SrYb_2O_4$, SrY_4O_7, and $SrYb_4O_7$ were formed in the systems. The compounds SrY_2O_4 and $SrYb_2O_4$ melt congruently at 2215 and 2200°C, respectively. The compounds SrY_4O_7 and $SrYb_4O_7$ are formed at 2080°C and exist up to the melting points of 2160 and 2190°C. A study of the effects of additions of SrO in the character of polymorphic transformations of Y and Yb oxides indicated that they may exist in B- and A-forms as well as the known C- and H-forms. Solid solutions based on the initial oxides (SrO, Y_2O_3, and Yb_2O_3) were also investigated. (auth)

28572 SYSTEM MgO–V_2O_5. Speranskaya, E. I. (Inst. of General and Inorganic Chemistry, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 10, 1611-13(Oct 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 10, 1804-7(Oct 1971).

The system MgO–V_2O_5 has been investigated; literature data on the composition of the compounds and the phase equilibria temperatures have been modified and the polymorphism of two vanadates established. Formation of compounds of the composition $MgO \cdot 2V_2O_5$ and $MgO \cdot V_2O_5$, described in the literature, has not been confirmed in this system. The ordinates of the vanadate composition are displaced toward concentrations greater than 50 mole % MgO; all the compounds found in this system melt incongruently: $3MgO \cdot 2V_2O_5$–at 760°C, $2MgO \cdot V_2O_5$–at 1132°C, and $3MgO \cdot V_2O_5$–at 1212°C. (auth)

28573 REACTION OF TITANIUM DIOXIDE WITH INDIUM OXIDE. Rozdin, I. A.; Spiridonov, F. M.; Komissarova, L. N.; Plyushchev, V. E. (Inst. of Fine Chemical Tech., Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 10, 1605-7(Oct 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 10, 1798-1800(Oct 1971).

In the reaction between titanium dioxide and indium oxide, it was established that the reaction product is indium titanate, In_2TiO_5, which is orthorhombic and has the following constants:

$a_0 = 10.47$; $b_0 = 9.895$; $c_0 = 14.51$ Å. The formation conditions of indium titanate have been elucidated and some of its physicochemical properties determined. (auth)

28574 PHASE DIAGRAMS OF THE SYSTEMS MOLYBDENUM CARBIDE–CARBIDES OF METALS OF GROUPS IV–V. Funke, V. F.; Pshenichnyi, I. V.; Loktionov, Yu. D.; Pliner, L. A. Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 10, 1561-6(Oct 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 10, 1748-54(Oct 1971).

Phase diagrams of the pseudobinary and pseudoternary systems Mo_2C–TiC(ZrC, NbC) and Mo_2C–ZrC–NbC were studied. The relation between the combined carbon content and the ratio between the metallic components in the systems Mo_2C–TiC(ZrC, NbC) were determined. The graph of the solid solution lattice constant versus the titanium, zirconium, and niobium carbide content of molybdenum carbide has been constructed. The hardness in the systems Mo_2C–TiC(ZrC, NbC) was measured. (auth)

28575 PHASE ANALYSIS OF THE ACTIVE COMPONENT OF VANADIUM CATALYSTS WHICH CONTAIN POTASSIUM. Khele, Z.; Maizel, A. (Karl-Marks Univ., Leipzig). Kinet. Katal.; 12: No. 5, 1276-82(Sep-Oct 1971). (In Russian).

The systems V_2O_5–K_2SO_4 and V_2O_5–$K_2S_2O_7$ were investigated by radiography and differential thermal analysis. Construction of the phase diagrams revealed the existence of compounds $5V_2O_5 \cdot 3K_2SO_4$ and $V_2O_5 \cdot 2K_2S_2O_7$. Eutectics were found at 31 mol% K_2SO_4 (mp 505°C) and 55 mol% K_2SO_4 (450°C) in the first system; in the second system one eutectic melting at 295°C had previously been noted (about 92 mol% $K_2S_2O_7$). (K.S.W.)

28576 THERMAL ANALYSIS OF THE VANADIUM PENTOXIDE–CALCIUM METAVANADATE. Fedorov, P. I.; Slotvinskii-Sidak, N. P.; Vorob'eva, G. V.; Andreev, V. K. (Moscow Inst. of Fine Chemical Tech.). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 14: No. 11, 1750-1(1971). (In Russian).

A phase diagram was constructed for the system V_2O_5–CaO for the region from V_2O_5 up to 50% CaO (mole percent). The eutectic composition melted at 613°C (13 mole% CaO). The formation of a metastable compound $CaO \cdot 4V_2O_5$ was noted which melted incongruently at 645°C, and which was destroyed upon annealing. (K.S.W.)

28577 PREPARATION AND CERTAIN PROPERTIES OF RHODIUM BORIDES. Kosenko, V. A. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 9, 2132-5(Sep 1971).

Translated from Zh. Prikl. Khim.; 44: No. 9, 2099-2102(Sep 1971).

Thermographic, x-ray diffraction, and metallographic analyses showed that the optimal conditions for synthesis of the compound Rh_7B_3 from the elements are 3 h of heating at 1000°, and for synthesis of the compound $RhB_{\sim 1.1}$, 40 h at 1000 to 1100°. The melting points of the compounds Rh_7B_3 and $RhB_{\sim 1.1}$ are 1140 and 1260°; the microhardness is 777 ± 25 and 1213 ± 35 kg/mm², respectively. (auth)

28578 TENSILE, HARDNESS, AND ELECTRIC PROPERTIES OF COPPER–ThO_2 DISPERSION ALLOYS. Fuschillo, N.; Gimpl, M. L. (Rutgers–The State Univ., New Brunswick, N. J.). J. Metals; 23: No. 5, 43-5(May 1971).

Dispersion strengthened alloys of copper containing 2.2 and 5.0 vol % ThO_2 were made by precipitating copper from a stirred solution of copper acetate containing a suspension of submicron sized ThO_2 particles. This procedure produced alloys of good oxide particle homogeneity in the metallic matrix. Mechanical properties and electrical resistivities were measured as a function of temperature. The dispersion strengthening caused small increases in the resistivity and large improvements in mechanical properties of the alloy compared with copper at elevated temperatures. Alloys containing 2.2 vol % thoria had sufficient ductility to permit fabrication into wire by cold swaging. (auth)

Metals and Alloys

28579 ELASTIC STATES DURING PHASE TRANSFORMATIONS. Madejski, J. Rozpr. Inz.; 17: No. 3, 333-46(1969). (In Polish).

Elastic states created by phase changes are analyzed by a proposed linear theory. Examples of a spherical reservoir and a thick-walled tube are given and the coexistence of stresses caused by temperature variations and phase transformations discussed. The importance of states of stress and strain created by nuclear radiation-induced phase changes is emphasized. (Appl. Mech. Rev.)

Corrosion and Erosion

Refer also to abstracts 27994, 28542, and 30181.

28580 (COO-3166-2) ENVIRONMENT AND FRACTURE. Informal Progress Report. Johnson, H. H. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). 21 Mar 1971. Contract AT(11-1)-3166. 16p. Dep. NTIS.

Results of investigations of hydrogen-induced cracking in high-strength steels are presented. Progress is reported on studies of hydrogen solubility and diffusivity in steel and hydrogen embrittlement of steel. (J.R.D.)

28581 (DUN-7745) IN-REACTOR CORROSION BEHAVIOR OF ETCHANT STAINED ZIRCALOY-2. Marx, E. R. (Douglas United Nuclear, Inc., Richland, Wash.). 2 Aug 1971. 23p. Dep. NTIS.

Results of tests indicate that in-reactor corrosion rates of Zircaloy-2 do not become catastrophic due to etchant contamination. Rate increases were noted between 59 and 104 days of exposure followed by a leveling off to a predictable uniform rate following a corrosion power curve. Non-stained sample evaluation results indicated this increase between 59 and 104 days suggesting that a neutron flux-induced increase may have occurred between $4.38 \times 10^{20} \eta\nu\tau$ and $8.47 \times 10^{20} \eta\nu\tau$ total neutron exposure. The total corrosion occurring even on samples dried 2.5 hours after etching does not appear catastrophic or detrimental to fuel element performance. Post-irradiation examinations of oxide thicknesses and uniformity are needed to substantiate this conclusion. The use of either hydrofluoric acid or ammonium acid or ammonium bifluoride as etchant does not appear to cause any corrosion rate difference. Prefilm treatments in high and low pressure steam versus as-etched sample exposure were found to affect the total corrosion occurring on test samples. Exposing coupons in the as-etched condition results in the least corrosion, while using a low pressure steam prefilm caused the greatest amount of corrosion. Hydrogen pickup, being an important parameter on Zircaloy clad performance has only been determined on the out-of-reactor comparison samples. The hydrogen percent theoretical pickup on these samples was normal. Funds are needed to obtain the hydrogen data from the in-reactor samples. Studies of factors influencing hydrogen pickup indicate that the in-reactor coupons in this test would not be expected to pick up an abnormal amount of hydrogen. Increases in Zircaloy-zirconium oxide interface temperatures are not expected to be greater than 5°F in the peak heat flux locations (350,000 BTU/hr-ft²) of fringe tubes in N Reactor. This possible temperature increase at the surface of the Zircaloy-2 cladding would not alter the corrosion rate of the cladding or interfere with the cladding performance. Reduction of Zircaloy clad thickness should not exceed .04 mils with the fuel exposed one year in 540°F coolant following a high pressure prefilm. The data from this test indicate that fuels can be safely irradiated if they have etchant staining on the Zircaloy-2 clad surface. (auth)

28582 (ORNL-TM-3763) ESTIMATED BEHAVIOR OF TITANIUM IN MSBR CHEMICAL PROCESSING SYSTEMS. Ferris, L. M. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 20p. Dep. NTIS.

Available thermodynamic information was used to estimate the behavior of titanium in a fluorination—reductive extraction flowsheet for processing MSBR fuel salt. It was first shown that titanium is likely to be leached from a titanium-modified Hastelloy N containment vessel into a LiF–BeF_2–ThF_4–UF_4 fuel salt at 600°C. The primary reaction would probably be $3\ UF_{4(d)} + Ti_{(Hastelloy)} = TiF_{3(d)} + 3\ UF_{3(d)}$. The estimates showed that, during fluorination, TiF_3 would be oxidized to TiF_4. A large fraction of the TiF_4 would be expected to volatilize during fluorination. Any titanium not volatilized by fluorination would be present in the salt that enters the reductive extraction step. Experimental data confirmed the prediction that titanium would be practically quantitatively extracted from the salt in this step. It was also shown that titanium can be transferred from a bismuth phase to a salt phase by oxidation with gaseous HF, and that HF is not a sufficiently strong oxidant to convert TiF_3 to TiF_4. (auth)

28583 PRESSURE IN REACTION BETWEEN SODIUM AND WATER AND ANALYSIS OF ITS PROPAGATION. Sakano, Kosuke; Tanaka, Yoshihisa; Mochizuki, Hiroji (Kawasaki Heavy Industires, Ltd., Kobe, Japan). FAPIG (Tokyo); No. 62, 84-9(Aug 1971). (In Japanese).

SOWACS, a unidimensional sodium-water reaction analysis code was developed. Values obtained for initial peak pressure which appeared at the reaction point was about twice as much as ex-

perimental values. To minimize this difference, it seemed to be better to change the model for sodium flow in the initial reaction from column to spherical model. According to results of analysis on propagation of pressure in the reaction between sodium and water, the pressure in an evaporator neighboring to a ruptured evaporator, a reheater and superheater, piping and intermediate heat exchanger (IHX) was 47 atm abs, 25 atm abs, and 18 atm abs, respectively, whereas, internal pressure of the ruptured evaporator was 126 atm abs, when number of steam generators was 10 in one loop for an atomic energy plant of 300,000 kW output. Thus, the pressure in various parts is much lower than that in the ruptured evaporator. This lowering of the pressure is merit-of-module type. It is easy to further decrease the pressure propagated to the neighboring evaporator, the reheater and superheater, the piping and IHX by changing design data for discharge system. (Japan)

28584 CERTAIN ASPECTS OF FRICTION AND FRETTING CORROSION PHENOMENA IN LIQUID Na. Fontaine, J. P. Corros.-Trait., Prot., Finition; 19: No. 7, 379-93(Nov 1971). (In French). (CONF-710348-1).

From second annual conference of the French corrosion center; Saint-Etienne, France (10 Mar 1971).

Fast neutron reactors involve mechanisms which must operate in high-temperature liquid Na. The surfaces of the structural parts are generally coated with austenitic stainless steel. The optimization of the performance depends upon the period of time during which the parts are immersed in the liquid Na prior to being subjected to any friction. Between 400 and 600°C a duration of 10 hours is sufficient to initiate physicochemical reactions between test bars and the Na. It was not possible to obtain wetting at 200°C, and thus correct and reliable performance of working parts at this temperature cannot be envisaged. Friction in the presence of vibrations was also studied. Results of a test were used to establish the effect of the amplitude of the motion (adhesion and transfer of materials at small amplitudes, hammering at large amplitudes). The colmonoy4/colmonoy5 couple behaved satisfactorily in the ball joint configuration investigated. (France)

28585 EFFECT OF HYDROGENATION AND ORIENTATION OF HYDRIDES ON THE RESISTANCE TO LOW-CYCLE FAILURE OF ZIRCONIUM–2.5 PERCENT NIOBIUM ALLOY. Filatov, V. M.; Rodchenkov, B. S.; Lupakov, I. S. Fiz.-Khim. Mekh. Mater.; 7: No. 6, 62-4(1971). (In Russian).

Samples of Zr-0.25% Nb alloy were annealed in a vacuum at 465°C and then hydrogenated with gaseous H_2 at 500°C until the H content was 0.02 or 0.05 wt %. Deformation of the samples occurred at the rate of nine cycles/min at room temperature. Hydrogenation decreased the resistance of the alloy to low-cycle deformation, especially when the hydrides were oriented perpendicular to the acting stress. (K.S.W.)

28586 CORROSION BEHAVIOR OF LEAD–INDIUM ALLOYS IN SULFURIC ACID SOLUTIONS. Bryntseva, V. I.; Bundzhe, V. V. G.; Dunaev, Yu. D. Tr. Inst. Khim. Nauk, Akad. Nauk Kaz. SSR; 24: 22-31(1969). (In Russian).

Corrosion of Pb–In alloys (component concentration 0 to 100%) in the absence of external polarization conforms to the Tamman law and increases sharply below 1 at.% Pb. During anodic polarization In exerts a slight protective effect at concentrations up to 4%, but at higher concentrations alloy resistance falls sharply. The corrosion behavior of the alloys was found to depend on the structure and electrochemical properties of the components. (Corros. Control Abstr.)

28587 PROTECTION OF TITANIUM, NIOBIUM, AND ALLOY ZhS–6K AGAINST HIGH-TEMPERATURE OXIDATION BY BERYLLIUM COATING IN MOLTEN SALTS. Ilyushchenko, N. G.; Kornilov, N. I. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 12, 85-91(1969). (In Russian).

Diffusion beryllium coatings formed in molten salts can be used for protection of Ti, Nb, and ZhS-6K. (auth)

28588 CORROSION AND CORROSION PRODUCT RELEASE IN NEUTRAL FEEDWATER. Brush, E. G.; Pearl, W. L. (General Electric Co., San Jose, Calif.). Corrosion; 28: No. 4, 129-36(Apr 1972).

The corrosion and corrosion products released from materials exposed to typical boiling water reactor (BWR) feedwater chemistries were determined over the temperature range of 38 to 204°C. The study included carbon steel, Type 304 stainless steel, and several common copper alloy feedwater heater tubing materials exposed to neutral pH, flowing high-purity water of varying dissolved oxygen levels. It was found generally that for acceptable resistance to corrosion in power plant feedwater at neutral pH, copper base alloys can be used only with no oxygen; carbon steel can be used when the dissolved oxygen exceeds 15 ppB; stainless steel can be used regardless of the oxygen content. (auth)

28589 EFFECT OF METALLURGICAL REACTIONS IN INCONEL NICKEL–CHROMIUM–MOLYBDENUM ALLOY 625 ON CORROSION RESISTANCE IN NITRIC ACID. Harris, J. A.; Scarberry, R. C. (International Nickel Co., Inc., Huntington, W. Va.). J. Metals; 23: No. 9, 45-9(Sep 1971).

Although Inconel 625, has good resistance to sensitization caused by carbide precipitation, some samples of the material have been found to have less resistance than others. Laboratory studies of the precipitation reactions in the alloy give no indication that any particular phase is responsible for the increased corrosion rate. The studies do show, however, that the degree of sensitization is related to the total chromium content of the precipitates, and that control of processing, particularly annealing procedures, can produce material having maximum resistance to sensitization. (auth)

28590 CORROSION RESISTANT ALLOYS 0N70M27F AND 0Kh15N65M16V. Svistunova, T. V.; Tufanov, D. G. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 9-10, 798-801 (Sep-Oct 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 9, 39-42(Sep 1971).

Properties of corrosion-resistant Ni-base alloys EP 496, (Mo–27%, V–1.5%) and EP 567 (Mo–16%, Cr–15%, W–3.5%) were examined. The best combination of bulk corrosion resistance and resistance to intercrystalline corrosion is obtained by quenching EP 496 in water from 1050 to 1100°C and by quenching EP 567 in water from 1000 to 1050°C. (J.R.D.)

28591 STRUCTURE AND PROPERTIES OF SILICON COATINGS ON ALLOY VN-2. Belyaeva, G. I.; Anfinogenov, A. I.; Ilyushchenko, N. G. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 9-10, 776-8(Sep-Oct 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 9, 63-5(Sep 1971).

The kinetics of siliconizing Mo–Nb-base alloys, using fused equimolar mixtures of KCl–NaCl–NaF–Na_2SiF_6, were studied. The treatment was found to provide protection for the alloy against high-temperature gas corrosion. The method is suitable for thick-walled and complex parts. (J.R.D.)

28592 USE OF VACUUM FOR PROTECTION OF NICKEL AND BERYLLIUM BRONZE AGAINST OXIDATION DURING HEAT TREATMENT. Naumkina, I. V.; Chertavskikh, A. K.; Tikhonov, B. S.; Korsunskaya, K. N. Tr., Gos. Nauch.-Issled. Proekt. Inst. Splavov Obrab. Tsvet. Metal.; No. 31, 54-61(1970). (In Russian).

A study was made on the influence of various gaseous media and vacuum on the oxidation, gas content, and mechanical properties of nickel and beryllium bronze. During heat treatment of alloys containing elements with an enhanced affinity for oxygen (Be, Cr, Mn, Si), the most effective means of protection against oxidation was vacuum. The residual pressure necessary to give a bright, non-oxidized surface at 300 to 800° was determined. The results of industrial tests and the introduction of heat treatment of nickel and beryllium bronze in a blast furnace in vacuum are also given. (Corros. Control Abstr.)

Preparation and Fabrication

Refer also to abstracts 28538 and 30103.

28593 (AD–732482) REPORT OF THE AD HOC COMMITTEE ON BERYLLIUM. Final Report. (National Materials Advisory Board (NRC), Washington, D. C.). Oct 1971. Contract DA-49-083-OSA-3131. 105p. (NMAB–281). NTIS.

The review, made to examine the role of the Department of Defense in using beryllium and in advancing the technology, found numerous advantageous applications in parts of important components. Present applications, such as for guidance systems, reentry vehicles, brakes, and thrust chambers, would suffer significant performance penalties if beryllium were not available. Several design trade-offs show beryllium to be competitive with, or superior to, filamentary composites, on a stiffness-to-weight basis, in advanced applications for lightweight structures. Increased usage of beryllium, however, will be unlikely without development work which is described. In addition to beryllium's unique capabilities, a major justification for support of beryllium technology is its usefulness as an option in the event that com-

petitive materials prove to be unsatisfactory in critical applications. Civilian applications (except in the form of an alloying element), now or foreseeable, are very limited because beryllium remains an expensive material. Accordingly, fulfillment of beryllium's potential advantages for military systems requires government support to ensure that beryllium in the required forms will be available, particularly for applications now being designed. Evaluation of pertinent standard cutting and forming operations and the newer fabrication operations in terms of cost and applicability are recommended. (auth) (NTIS)

28594 (CEA-N-1507) MODIFICATION TO AN ELECTRON MICROPROBE FOR THE EXAMINATION OF RADIOACTIVE SAMPLES. PREPARATION OF THE SAMPLES. Morlevat, Jean-Pierre; Janvier, Jean-Claude; Roussignol, Jacques (Commissariat a l'Energie Atomique, Grenoble (France), Centre d'Etudes Nucleaires). Dec 1971. 16p. (In French). Dep. NTIS (U. S. Sales Only).

Using a commercial type microprobe for irradiated samples examinations requires a number of modifications to be effected; $\beta-\gamma$ activities ranging from 0.5 to Ci at 0.9 MeV can thus be accommodated. Emphasis was also put on specimen preparation in order to prevent any microprobe contamination. (France)

28595 (CNLM-3903) HEAT TREATMENT RESPONSE OF TWO COLUMBIUM BASE ALLOYS. Delgrosso, E. J.; Carlson, C. E.; Kaminsky, J. J. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). [1961]. Contract [AT(30-1)-2789]. 42p. Dep. NTIS.

Declassified 3 Nov 1971.

An investigation was made of the recrystallization, recovery, and grain growth characteristics of Nb-5 Mo and Nb-5 Mo-2 Ti-2 Zr. Both alloys were capable of being hot and/or cold worked as required for practical fabrication processes. The various heats of activation for recrystallization were determined for both alloys and were a function of the degree of cold work and the amount of recrystallization attained. The recovery characteristics of both alloys were determined as a function of the degree of cold reduction. The effect of annealing treatment on the growth of recrystallized grains also was studied. The aging of Nb-5 Mo-2 Ti-2 Zr was investigated. Microstructural examination of Nb-5 Mo-2 Ti-2 Zr revealed the presence of Mo_2Zr, carbide and/or nitride phases in this alloy and possibly ZrO_2. (auth)

28596 (RDT-E-1-9-T(3-72)) STAINLESS STEEL GATE VALVES, MANUAL AND POWER OPERATED. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Mar 1972. 30p. RSO.

A standard prescribing requirements for stainless steel gate valves, manual and power operated for nuclear and associated applications is presented. (J.R.D.)

28597 (RDT-E-1-12-T(3-72)) STAINLESS STEEL CHECK VALVES. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Mar 1972. 21p. RSO.

A standard prescribing requirements for stainless steel check valves for nuclear and associated applications is presented. (J.R.D.)

28598 (RDT-E-21-T(3-72)) STAINLESS STEEL GLOBE AND ANGLE VALVES, MANUAL AND POWER OPERATED. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Mar 1972. 31p. RSO.

A standard prescribing requirements for stainless steel globe and angle valves, manual and power operated for nuclear and associated applications is presented. (J.R.D.)

28599 (UCRL-72853(Rev.1)) KINETICS OF CHEMICAL VAPOR DEPOSITION OF TUNGSTEN. Cheung, Henry (California Univ., Livermore. Lawrence Livermore Lab.). 7 Dec 1971. 13p. (CONF-720410-1). Dep. NTIS.

From third international conference on chemical vapor deposition; Salt Lake City, Ut. (24 Apr 1972).

The rate of chemical vapor deposition (CVD) of tungsten by reduction of tungsten hexafluoride with hydrogen under surface-process limiting conditions may be interpreted in terms of activated adsorption of hydrogen as rate-limiting—provided it is assumed that the metal surface is covered only sparsely with reactant and product gases. A rate expression derived on this basis was found to agree with the available data. The data can be interpreted also equally well in terms of activated desorption of hydrogen fluoride as the rate-limiting step—provided it is assumed that the surface is almost entirely covered with fluorine atoms. Experimental studies of the effects of rate-retarding additives (poisons) are suggested as a method for determining which of the two proposed mechanisms is correct. (auth)

28600 (UCRL-73246) EFFECTS OF ADDITIVES ON THE DEPOSITION RATE OF CVD TUNGSTEN. Huegel, F. J.; Fung, E.; Cheung, H.; Holman, W. R. (California Univ., Livermore. Lawrence Livermore Lab.). 7 Dec 1971. 11p. (CONF-720410-4). Dep. NTIS.

From third international conference on chemical vapor deposition; Salt Lake City, Ut. (24 Apr 1972).

The effects of several additives (HCl, O_2, H_2O, and HF) on the deposition rate of fluoride tungsten were measured over a range of concentrations and plating conditions. Hydrogen fluoride had no effect. The other additives poisoned the surface and reduced the rate significantly. Results are correlated and discussed in terms of current theories on the kinetics of tungsten deposition. It was concluded that activated adsorption of hydrogen is probably the rate-limiting step when tungsten is deposited under surface-controlled conditions. (auth)

28601 SOME INTRODUCTORY INVESTIGATIONS ON ELECTROLYTIC DEPOSITION OF Y-Al AND Y-Mg ALLOYS. Bratland, D.; Booe, G. H.; Grjotheim, K.; Rensvik, H.; Aamland, E. (Technical Univ. of Norway, Trondheim). Rev. Roum. Chim.; 17: No. 1-2, 41-8(Jan-Feb 1972).

Yttrium-magnesium and yttrium-aluminum were produced by electrolysis of Y_2O_3 in $LiF-YF_3$ melts using floating cathodes of liquid magnesium and liquid aluminum, respectively. The maximum concentrations of yttrium obtained were 48.8 wt % for Y-Mg alloy and 22.0 wt % for Y-Al alloy. The density of the electrolyte determined the upper limit of yttrium concentration in the alloys. It was also found that cathode current efficiency decreased with increasing yttrium content of the alloys. (auth)

28602 PROBLEMS IN NUCLEAR IRON MAKING. Shimanuki, Ryoichi (Japan Atomic Energy Research Inst., Tokyo). FAPIG (Tokyo); No. 61, 2-7(May 1971). (In Japanese).

Iron and steel making industry procedures are described for direct use of nuclear fission energy in production of reducing gases and for obtaining reduction-reaction heat for iron ore, and for application of low-cost nuclear power in producing steel directly from the reduced iron. In introduction of new nuclear energy processes into the iron and steel industry, the following are described: new procedure by nuclear energy, its scale and productivity, its relation with the industry's future program, high temperature in nuclear iron-making, and systems necessary for development of the nuclear procedures. (Japan)

28603 WELD CRACK SENSITIVITY IN Nb-CONTAINING AUSTENITIC STAINLESS STEELS. Snykers, M.; De Boeck, P.; Meulemans, M.; Cools, A.; Schrijvers, J. (SCK-CEN, Mol-Donk, Belgium). Kernenergie; 14: No. 9, 290-7(Sep 1971).

Experiments for welding end-plugs to tubes both in German austenitic stainless steels Werkstoff Nr. 4988 and 4961 are described. A change of the welding parameters has a great influence on the weld crack sensitivity. It is shown that the niobium carbide inclusions affect the weld crack sensitivity. If the cross-section of these inclusions is smaller than about 4 to 8 μm^2 no cracks were observed. (auth)

28604 DEPOSITION OF NIOBIUM FILMS FROM THE GAS PHASE. Korzo, V. F.; Lyashchenko, G. A.; Kozyrkin, B. I.; Rumyantseva, V. P. (Moscow Automobile-Highway Inst.). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 10, 1649-50(Oct 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 10, 1849-50(Oct 1972).

Attempts were made to obtain Nb films by pyrolysis of $NbCl_5$ vapor in a soft vacuum. The process was carried out in a vacuum of 10^{-1} to 10^{-2} mm hg, the temperature in the reactor being 850 to 900°C and that in the evaporator about 180°C. The microstructures of pyrolytic Nb films deposited on various substrates were studied with the aid of optical and electron microscopy. The results showed that the film consisted of many separate crystal particles, some laminar, some acicular. The microrelief of the surface was highly developed. The mean grain dimension was 3 to 5 μ, indicating a fairly high degree of crystallinity in the film obtained from the gas phase. Preferential grain growth occurred on roughnesses in the substrate, which also acted simultaneously as centers of crystallization. The transition temperature T_k, to the superconducting state was found to be 716 to 7.8°K. (P.C.H.)

28605 HYDROSTATIC EXTRUSION OF HARD CORE CLAD ROD. Zoerner, W.; Austen, A.; Avitzur, B. Contract AT (30-1)-4078. J. Basic Eng.; 94: No. 1, 78-80(Mar 1972).

The processing of coaxially extruded composite wire is examined with emphasis on the bond between the outer sleeve material and the inner core material. Copper clad with solder was used in one series of experiments while an Nb-base Ti alloy clad with Al was used in another series. Results are discussed and presented graphically. (J.R.D.)

28606 PRESENT SITUATION ON DEVELOPMENT OF FUEL CLADDING TUBES FOR FAST REACTORS. Okada, Takeshi (Kobe Steel, Ltd., Japan). FAPIG (Tokyo); No. 61, 25-8(May 1971). (In Japanese).

Conforming to the construction schedule for the Joyo experimental fast breeder reactor, trial manufacture of Type 316 stainless steel fuel cladding tubes has continued. Joyo will be operated in temperature range of 250 to 650°C, under internal pressure of 100 kg/cm^2. The total amount of irradiation during two years will reach 10^{23} nvt. Under these conditions, permissible swelling rate of fuel cladding tubes is less than 1.4% imposing strict requirements on these tubes. Advanced manufacturing methods and quality control procedures for 316 stainless steel fuel cladding tubes are listed. The main points are as follows. For decrease of gaseous components and improvement of cleanness, vacuum arc melting is adopted. Balance of strength and toughness and dimensional accuracy are attained by cold working after solution treatment. Cobalt, boron, and nitrogen must be limited to very small amounts. Higher ultimate strength than that for ordinary stainless steels is required. This strength can be achieved by the degree of finished cold working. Ultrasonic defect detection, hydraulic testing, and color infiltration tests are employed for nondestructive testing. Until now, 6000 fuel cladding tubes have been manufactured for trial. Final trial manufacture is being carried out for deciding practical design of the fuel cladding tubes. (Japan)

28607 NUCLEAR FUEL FABRICATION. Tarasuk, W. R. (to Canadian General Electric Co., Ltd.). Canadian Patent 891,194. 18 Jan 1972.

Loss of fuel pellets during fabrication has resulted because the dished pellet ends, which provide an expansion allowance, are prone to chipping. It is possible to salvage the pellets by machining the damaged end to give a plain end face, but this renders the pellet unsuitable for use in standard fuel assemblies. By providing a compensated end plug to the sheath of the element with a dished inner surface facing the machined fuel pellet, the need to reprocess the damaged pellet is overcome. As an alternative, additional expansion allowance may also be provided by dishing both ends of one or more adjacent pellets. (Canada)

Properties, Structure, and Phase Studies

Refer also to abstracts 27874, 27973, 27987, 28535, 28545, 28670, 29452, 29855, 30106, 30107, 30114, 30124, and 30201.

28608 (AEC-tr-7212) PHYSICAL CHEMISTRY OF ALLOYS AND REFRACTORY COMPOUNDS OF THORIUM AND URANIUM. Ivanov, O. S. (ed.) Translation of Fiziko-khimiya splavov i tugoplavkikh soedinenii s toriem i uranom, Izdatel'stvo Nauka, Moscow, 1968. 267p. (TT-71-50053; IPST-Cat.-5999). Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 51061.

28609 (ANL-7775, pp 37-63) SODIUM TECHNOLOGY. Burris, L.; Draley, J. E.; Cafasso, F. A.; Nelson, P. A. (Argonne National Lab., Ill.). Apr 1971.

In Chemical Engineering Division annual report, 1970.

Progress is reported in the field of sodium technology including studies of the chemical behavior of nonmetallic impurities in sodium, the establishment of a national program to coordinate sampling and analytical methods for determining impurities in sodium and cover gases, establishment of a national program to provide meters for monitoring levels of nonmetallic impurities in operating sodium systems, and methods for detecting fuel element failures. (D.H.M.)

28610 (ANL-7775, pp 103-50) CHEMISTRY OF LIQUID METALS AND MOLTEN SALTS. Tevebaugh, A. D. (Argonne National Lab., Ill.). Apr 1971.

In Chemical Engineering Division annual report, 1970.

Progress is reported on studies of the chemistry and thermodynamics of liquid metals and molten salts including thermodynamic and phase equilibrium studies of chalcogen-containing systems; theoretical studies of gas solubilities in liquid metals; transport properties of sulfur-containing systems; surface diffusivity of iron in liquid sodium; Raman spectra of phosphorus chalcogen compounds, the iodate ion, and divalent metal ions; and the development of metal/chalcogen secondary electrical batteries for vehicle propulsion and for powering an artificial heart. (D.H.M.)

28611 (BBC-101) INVESTIGATION OF INTERMETALLIC COMPOUNDS FOR VERY HIGH TEMPERATURE APPLICATIONS. Quarterly Progress Report, October 1–December 31, 1958. Stonehouse, A. J.; Paine, R. M.; Beaver, W. W. (Brush Beryllium Co., Cleveland, Ohio). 15 Jan 1959. Contract AT(30-1)-541. 21p. Dep. NTIS.

Declassified 28 Oct 1971.

Studies have shown the intermetallic composition $(U,Zr)Be_{13}$ containing 10 weight % uranium has an average modulus of rupture of about 45,000, 34,000, and 22,000 psi at 2300, 2500, and 2700°F, respectively. UBe_{13} apparently does not form a solid solution with $NbBe_{12}$, but a mixture of the two phases containing 10% uranium showed 37,000, 27,800, and 17,900 psi modulus of rupture at 2300, 2500, and 2750°F, respectively. Short-time oxidation (5 hours) indicates that oxidation resistance should be comparable to that of $NbBe_{12}$ with the mixed phases. (auth)

28612 (HEDL-TME-71-133) TENSILE PROPERTIES OF PROTOTYPIC FTR VESSEL WELDMENT MATERIALS (RM-15). Ward, A. L. (Hanford Engineering Development Lab., Richland, Wash.). Sep 1971. Contract AT(45-1)-2170. 12p. Dep. NTIS.

Tensile properties were determined for prototypic FTR vessel weldment materials. The weld deposited materials are representative of the fabrication welds used in the upper- and lower-intermediate vessel shell courses with regard to electrode type and chemistry, base plate thickness and chemistry, and welding procedure. Weld deposits were produced by the manual shielded metal-arc process using a ¼-inch diameter flux-coated electrode developed specifically for fabrication of the FTR vessel. Two types of deposits were produced: a butt weld (15° included angle) made in 2⅜-inch thick Type 304 plate and a weld pad ~1¼-inches thick made up simply of multiple weld passes built-up on a plate surface. The important features of the tensile behavior of the FTR vessel weldment materials are summarized below. No strong effect of directionality was exhibited by the weldment materials in short-term tensile tests. Strengths and ductilities were, however, slightly higher for the longitudinally oriented specimens than for the transverse case. Weld-deposited metal was both stronger and less ductile than the wrought base plate. Base plate properties were consistent with the industry-wide consensus for Type 304 stainless steel. Composite specimens generally exhibited tensile properties which were intermediate to those of the weld metal and base plate. All fractures occurred in weld metal. All specimens containing weld metal showed a reduced ability to work-harden compared to base plate material. All weld-containing specimens showed ductilities exceeding the minimum 10% residual end-of-life total elongation value specified for the FTR vessel and heavy-section components. Additional work is required to determine the extent, if any, to which FTR operating conditions will degrade the as-fabricated weld material properties. (R.C.K.)

28613 (IS-T-514) ELECTROTRANSPORT OF CARBON, NITROGEN, AND OXYGEN IN ZIRCONIUM. Swanson, Carl Emil Jr. (Ames Lab., Iowa). Apr 1972. Contract W-7405-eng-82. 59p. Dep. NTIS.

Thesis.

From electrotransport studies the mobilities, effective charges, and diffusion coefficients of carbon, nitrogen, and oxgyen in β zirconium were determined at 1625, 1700, and 1800°C. In conjunction with this investigation the specific resistivity and solid solubility of carbon in β zirconium were also determined as a function of temperature. Efforts to purify zirconium by electrotransport were severely limited by the low mobility of carbon. Attempts to prepare zirconium metal with a low carbon content by the van Arkel process for use in subsequent electro-transport purification experiments are described. (auth)

28614 (LBL-437) CORRELATION OF THERMO-MECHANICALLY VARIED MICROSTRUCTURES WITH SUPERCONDUCTING PROPERTIES OF Nb_3Sn PROCESSED BY A NEW POWDER METALLURGY TECHNIQUE. Babu, B. Naga Prakash (California Univ., Berkeley. Lawrence Berkeley Lab.). Dec 1971. Contract W-7405-eng-48. 47p. Dep. NTIS.

Thesis.

A flexible, stable Nb_3Sn composite was fabricated by a new powder metallurgy technique. Related studies and optimization of parameters in each step of the fabrication were made. The dependence of transition temperature on microstructural aspects was considered; an explanation was offered for the lowering of T_c

at higher reaction temperatures and the effect of reaction time is discussed. Short sample tests were made and current densities at dc fields up to 80 kG were measured; flexibility and stability were tested. An evaluation of all the process parameters was made and an optimum process schedule was developed. The T_c for most samples ranged from 18.1 to 18.45°K. The current density in the Nb_3Sn phase was around 2.7×10^5 A/cm^2 at 80 kG. (auth)

28615 (ORO-4076-1) BEHAVIOR OF WELDED JOINTS IN STAINLESS AND ALLOY STEELS AT ELEVATED TEMPERATURES. An Interpretive Report of the Available Data. Gilliland, R. G. (Wisconsin Univ., Milwaukee). 30 Jun 1971. Contract [AT(40-1)-4076]. 51p. Dep. NTIS.

Results of a literature search on properties of weldments in Types 304 and 316 stainless steel and Croloy are presented. Data tables are included on stress rupture, ductility, tensile strength, and yield strengths. (J.R.D.)

28616 (SC-DC-721202) METAL RESPONSE UNDER EXPLOSIVE LOADING. Jones, O. E. (Sandia Labs., Albuquerque, N. Mex.). [1972]. 24p. (CONF-720303-2). Dep. NTIS.

From twelfth annual symposium of the ASME, Albuquerque, N. Mex. (2 Mar 1972).

The formation and propagation of a shock pulse produced by detonation of an explosive in contact with an inert solid are briefly discussed with the overall aim of better understanding explosive metalworking. Simple techniques were developed for describing how plane shock waves are transmitted and reflected at material interfaces. The occurrence and prevention of spallation (dynamic fracture) are considered. Capabilities for high-speed numerical computation were surveyed because they are now sufficiently advanced to be routinely used for designing explosive operations and understanding material response. Finally, metallurgical effects produced by explosive hardening are summarized, and some practical applications are discussed. (auth)

28617 (UJV-2708-M) PHYSICAL PROPERTIES OF ZIRCONIUM AND ITS ALLOYS. Pav, T.; Saxl, I. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1971. 119p. (In Czech). Dep. NTIS (U. S. Sales Only).

The selected physical properties (density, thermal, electric and magnetic properties, elastic constants, and internal friction) of zirconium and its alloys are reviewed. The literature survey covers the published data up to 1971. A total of 111 references is given. (auth)

28618 VNUTRENNEE TRENIE V METALLICHESKIKH MATERIALAKH. (Internal Friction in Metallic Materials). Tavadze, F. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). 208p.

This book contains 42 papers by different authors which are grouped as follows: internal friction resulting from point and dislocation defects, damping as related to division boundaries and phase conversions, and magnetic losses. Of particular interest are the several papers covering certain properties of molybdenum, e.g., relaxation spectra, the recovery of internal friction of strongly deformed Mo, and the interaction of point defects and dislocations in Mo monocrystals. One paper discusses thermal annealing of radiation damage in metals as evaluated by internal friction. The internal friction of alloys of Fe, Cu, brass, TiNi, and a number of steels is described by several papers. (K.S.W.)

28619 BEHAVIOR OF INTERSTITIAL OXYGEN ATOMS IN Ti, Zr, AND Hf. Hirabayashi, Makoto; Yamaguchi, Sadae (Tohoku Univ., Sendai). Nippon Kinzoku Gakkai Kaiho; 10: No. 9, 591-601(Sep 1971). (In Japanese).

Methods of sample preparation, properties of solid solutions of Ti-O, Zr-O, and Hf-O systems, orderly arrangement of interstitial oxygen atoms, transformation of the interstitial super-lattice, phase equilibrium diagrams, mode of binding between metal and oxygen, and state of electrons are reviewed. Specimens reported in the literature were prepared either by gas-solid reactions (oxygen diffusion) or by melting. The orderly structure of oxygen in Ti, Zr, and Hf is not the same. The structure varies depending upon interaction of the oxygen and the metal. One characteristic common to the three systems is that the oxygen atoms in the metals tend to stay as far away as possible from each other. This tendency is also required from a theoretical viewpoint i.e., potential energy is lowest when the oxygen atoms stay apart from one another. The bond between the oxygen atoms and the metals is essentially metallic. However, resonance covalent bonding sometimes appears. Most of interstitial alloys in general have little solubility, but the oxygen in Ti, Zr, and Hf has large solubility as much as 20 to 30 atomic percent, so these systems are especially suited for study of the interstitial alloys. (Japan)

28620 HIGH-TEMPERATURE DISLOCATION REARRANGEMENT IN LIGHTLY COLD-DEFORMED NIOBIUM. Carvalhinhos, H.; De Faria, L. Lynce; Sequeira, Jose Almeida; Monteiro, J. Cunha (Laboratorio de Fisica e Engenharia Nucleares, Sacavem, Portugal). J. Less-Common Metals; 27: No. 1, 1-8 (Apr 1972).

The etch-pit technique was used to evaluate the kinetics of the dislocation density decrease in lightly deformed niobium as a function of time and temperatures between 1000 and 1200°C. The results showed that the initial large drops in dislocation density are simultaneous with dislocation rearrangement during the formation of two dimensional networks. It is believed that after this mechanism is exhausted, the dislocation density reduction is increasingly controlled by the mutual annihilation of three dimensional network dislocations, according to a model developed by Friedel. (auth)

28621 ELASTIC CONSTANTS OF URANIUM-7.5 PERCENT NIOBIUM-2.5 PERCENT ZIRCONIUM AS A FUNCTION OF PRESSURE. Abey, A. E.; Joslyn, E. D. (Univ. of California, Livermore). J. Less-Common Metals; 27: No. 1, 9-15(Apr 1972).

The elastic constants of uranium-7.5 wt % niobium-2.5 wt % zirconium (Mulberry) were measured in the pressure range from 1 bar to 18 kbar (1 bar = 10^5 n/m^2). Initial values of C_{11} and C_{12} were found to be 1.34 and 0.92 mbar. For dC_{11}/dP and dC_{12}/dP, values of 5.8 and 4.1 were obtained. The initial bulk modulus, K, was 1.06 mbar, and dK/dP was determined to be 4.6. (auth)

28622 OBSERVATIONS ON INTERMETALLIC COMPOUND AND CARBIDE PRECIPITATION IN TWO COMMERCIAL NICKEL-BASE SUPERALLOYS. Ramaswamy, V.; Swann, P. R.; West, D. R. F. (Imperial Coll. of Science and Tech., London). J. Less-Common Metals; 27: No. 1, 17-26(Apr 1972).

An electron microscopy study was made on precipitation in two commercial nickel-base superalloys. Alloy C263 was strengthened by the precipitation of fine dispersions of coherent γ', and $M_{23}C_6$ precipitation occurred at grain boundaries (M was predominantly Cr). Inconel 718 was strengthened by the precipitation of bct $Ni_3Nb(\gamma'')$ while overaging was associated with particle coarsening and with the formation of orthorhombic Ni_3Nb. NbC precipitation occurred at grain boundaries. (auth)

28623 STRUCTURAL STABILITY OF THE GADOLINIUM-TRANSITION METAL COMPOUNDS WITH THE Fe_3C STRUCTURE. Poldy, C. A.; Taylor, K. N. R. (Univ. of Durham, Eng.). J. Less-Common Metals; 27: No. 1, 95-7(Apr 1972).

Measurements were made on the pseudobinary series described by $Gd_3(Fe,Co)$ and $Gd_3(Co,Ni)$ in order to study the effects of 3d-electron concentration in this type of material. The samples were prepared by melting together the constituent elements in an argon arc furnace. Subsequently, parts of the samples were annealed for several days in order to improve the specimen homogeneity. Comparison of the annealed and as-cast samples showed that, in general, the structural and magnetic properties were essentially unaffected by this treatment. (P.C.H.)

28624 REACTION OF $MoCl_5$ AND $MoOCl_4$ WITH VANADIUM PENTOXIDE. Eliseev, S. S.; Glukhov, I. A.; Vozhdaeva, E. E.; Narzikulova, R. M. (Inst. of Chemistry, Dushanbe, USSR). Dokl. Akad. Nauk. Tadzh. SSR; 14: No. 11, 32-5(1971). (In Russian).

The reaction of chloride derivatives of molybdenum with V_2O_5 was studied by a thermographic method. The reaction $V_2O_5 + 3\ MoOCl_4 \rightarrow 2\ VOCl_3 + 3\ MoO_2Cl_2$ began as soon as the melting-point of $MoOCl_4$ was reached (about 172°C) was exothermic. The reaction $V_2O_5 + 3\ MoCl_5 = 2\ VOCl_3 + 3\ MoOCl_3$ was initiated by a temperature of 90° with a significant evolution of heat. The formation of coordination compounds from reactants and products together was noted. (K.S.W.)

28625 STRUCTURE OF β-URANIUM. Donohue, Jerry; Einspahr, Howard (Univ. of Pennsylvania, Philadelphia). Acta Crystallogr., Sect. B; 27: 1740-3(1971).

During a review of the various structures of uranium, indexing errors that affected a number of the investigations of the β allotrope were discovered. These errors have been corrected, and least-squares refinements performed in the three possible space groups, $P4_2/mnm$, $P4_2nm$, and $P\bar{4}n2$, with resulting R_1 values of 0.28, 0.24, and 0.28, respectively. It was concluded that the β-uranium powder data (Thewlis, 1952) cannot be used to determine the correct space group. (auth)

28626 CRYSTAL STRUCTURE OF UZn_{12}. Mason, J. T.; Chiotti, P. (Ames Lab., Iowa). Acta Crystallogr., Sect. B; 27: 1789-92(1971).

The crystal structure of the most zinc-rich compound in the uranium–zinc system was found to be hexagonal with space group symmetry P6/mmm. Crystals formed by cooling a 95 wt % zinc alloy had a composition range of $UZn(10.4 - 11.0) \pm 0.1$ as determined by microprobe analysis; lattice parameters were $a = 8.950 \pm 0.001$ and $c = 8.902 \pm 0.002$ Å. The structure was based on an ideal UZn_{12} stoichiometry, but substitution between pairs of zinc atoms and uranium atoms led to lower concentrations of zinc, $UZn_{10.4}$ being found for the crystal studied. The reported equivalence of the $SmZn_{12}$ and UZn_{12} structures based on powder work was confirmed. They differed only in the extent of substitution at different lattice sites. (auth)

28627 REACTION OF SELENIUM VAPOUR WITH MOLYBDENUM METAL. Dutrizac, J. E. (Dept. of Energy, Mines, and Resources, Ottawa). Can. Met. Quart.; 10: No. 2, 115-20 (Apr 1971).

The kinetics of the reaction of selenium vapor with molybdenum metal have been studied thermogravimetrically in the temperature range 430 to 562°C and for a total selenium pressure of 3.4 torr. At temperatures above 500°C, the kinetics are pseudo-parabolic and the temperature dependence of the reaction suggests an apparent activation energy of 16.5 ± 3 kcal/mole. Below 500°C, the kinetics are initially linear. The only reaction product formed under all conditions was hexagonal $MoSe_2$. (auth)

28628 EFFECT OF SURFACE PROCESSES ON HYDROGEN PENETRATION THROUGH MOLYBDENUM. Zakharov, A. P.; Sharapov, V. M. (Inst. of Physical Chemistry, Moscow). Fiz.-Khim. Mekh. Mater.; 7: No. 6, 54-8(1971). (In Russian).

The coefficients of penetration, diffusion, and solubility of hydrogen in molybdenum were determined over the temperature range 400 to 1,200°C and pressures of 1 to 200 torr. The surface of the metal acted as an energy barrier for hydrogen penetration, being characterized by a sufficiently small rate constant, but within the metal an intense, diffusing removal of dissolving hydrogen occurred, established by the diffusion coefficient and concentration gradient. (K.S.W.)

28629 PHASE ANALYSIS OF NIOBIUM ALLOYS. Kuz'minskaya, L. N.; Sosulina, I. A. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 9, 1302-5(Sep 1971).

Translated from Zavod. Lab.; 37: No. 9, 1029-32(Sep 1971).

Results of research directed to phase analysis of Nb alloys is reported. Phase isolation by electrolyte and phase composition determination by physicochemical methods are described. Data on phase composition and x-ray diffraction are also included. (J.R.D.)

28630 CORRELATION OF THE TENSILE STRENGTH OF METALS WITH THEIR SURFACE ENERGY AND WORK FUNCTION. Egiev, V. G. Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 11, 1623-5(Nov 1971).

Translated from Zh. Fiz. Khim.; 45: No. 11, 2871-4(Nov 1971).

The validity of an equation representing the correlation is shown. The expression is used to deduce formulas for calculating the tensile strength of pure metals and their alloys. (J.R.D.)

28631 DETERMINATION OF THE ELASTIC CONSTANTS OF BERYLLIUM IN THE TEMPERATURE RANGE 25 TO 300°C. Rowland, W. D.; White, J. S. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Phys., F (London); 2: No. 2, 231-6(Mar 1972).

The five independent elastic stiffness constants of beryllium were measured in the temperature range 25 to 300°C, using a direct pulse ultrasonic technique. At 25°C the values for the elastic constants are: $C_{11} = 28.88$, $C_{33} = 35.42$, $C_{44} = 15.49$, $C_{12} = 2.01$ and $C_{13} = 0.47$ in units of 10^{11} dyn cm^{-2}. The macroscopic elastic moduli, computed from the experimental data, agree well with the already accepted values for polycrystalline beryllium. (auth)

28632 THEORETICAL PHONON SPECTRA AND HEAT CAPACITY OF ZIRCONIUM. Kushwaha, S. S. (Banaras Hindu Univ., India). J. Phys., F (London); 2: No. 2, 257-61(Mar 1972).

Krebs model is used to study the lattice dynamics of zirconium, which belongs to the transition class of hcp metals. Phonon dispersion relations along the symmetry directions as well as $\theta - T$ curve compares well with the experimental results. (auth)

28633 DETERMINATION OF THE CRYSTALLOGRAPHIC ORIENTATION OF YTTRIUM SINGLE CRYSTALS. Voskresenskaya, L. A.; Petukhova, A. S. Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 32: 208-10(1971). (In Russian).

Determinations were made of the orientation of single crystals of Y. Standard stereographic projections in the (0001), (1012), (1010), and (1210) planes were obtained for hexagonal systems having $c/a = 1.571$. (Referativnyi Zh.)

28634 EFFECT OF Al ON THE VARIOUS PROPERTIES OF Ti–15 Mo BASE BETA ALLOYS. Ohtani, Shitoshi; Nishigaki, Minoru (Kobe Steel Ltd., Japan). J. Jap. Inst. Metals; 36: No. 1, 90-5(Jan 1972). (In Japanese).

Though Ti–15 Mo–5 Zr shows, as given previously, such excellent characteristics as corrosion resistance, cold workability, and weldability, and is placed under several practical applications, the stability and the resistance to oxidation of the alloy is not satisfactory. With the intention of improving these imperfections in Ti–15 Mo–5 Zr, the effects of Al additions on the various properties, such as thermal and mechanical stability of beta phase, forgeability, cold workability, aging property, oxidation resistance, and corrosion resistance, were studied. Three Ti–15 Mo–5 Zr base alloys and three commercial or semicommercial alloys were used. Though the embrittlement of Ti–15 Mo–5 Zr after slow cooling was much reduced by the addition of 3% Al, because Al suppressed and retarded the omega precipitation, Ti–15 Mo–5 Zr–3 Al–2 V was superior to Ti–15 Mo–5 Zr–3 Al so far as corrosion resistance was concerned. The latter alloy showed a marked hardening during the aging at rather high temperature, because Al strengthened the precipitates. This alloy is expected to be an excellent age hardenable alloy for construction application. There was no fundamental difference of oxidation resistance between Al-bearing and Al-free Ti–15 Mo–5 Zr alloys. The forgeability and cold workability of the alloy was not so much affected by 3% Al addition. (auth)

28635 STUDY OF MICROSEGREGATION OF Al IN Ti–Al BINARY ALLOYS AND COMMERCIAL TITANIUM ALLOYS. Tokuda, Shoichi; Kawahara, Hiromichi (Kobe Steel, Ltd., Japan). J. Jap. Inst. Metals; 36: No. 1, 8-13(Jan 1972). (In Japanese).

Following a previous study on the microsegregation of β stabilizing elements in binary and commercial titanium alloys, the effects of cooling rate from the β phase and the content of the alloying element Al on the microsegregation of Al were quantitatively investigated in Ti–Al binary alloys and in commercial titanium alloys such as Ti–8 Al–1 Mo–1 V, Ti–6 Al–4 V, Ti–5 Al–2 Cr–1 Fe, Ti–4 Al–3 Mo–1 V, and Ti–16 V–2.5 Al using an electron probe microanalyzer (EPMA). The results showed that microsegregation of Al is affected by the cooling rate from β phase, but is not greatly affected by the content of Al. In the examination with parameters such as the segregation index, the effective distribution coefficient and the α stabilizing rate, the genetic trend of microsegregation of Al was smaller than that of β stabilizing elements. In single phase alloys the concentration of Al was high inside grains and low in the neighborhood of boundaries. In two phase ($\alpha + \beta$) alloys, the concentration of Al was high inside grains and low in the β phase. The genetic trend of microsegregation of Al in commercial titanium alloys was scarcely affected by kind and amount of the co-existing β stabilizing element. (auth)

28636 STUDY OF MICROSEGREGATION IN Ti–Mo AND Ti–V BINARY ALLOYS AND COMMERCIAL TITANIUM ALLOYS. Tokuda, Shoichi; Kawahara, Hiromichi (Kobe Steel, Ltd., Japan). J. Jap. Inst. Metals; 36: No. 1, 1-8(Jan 1972). (In Japanese).

As a quantitative microsegregation study of titanium alloys by means of EPMA, following a previous report on Ti–Fe and Ti–Cr binary alloys, a series of experiments was carried out on the effects of cooling rate from the β phase and contents of the alloying elements such as Mo and V for Ti–Mo and Ti–V binary alloys and commercial titanium alloys. The results showed that the examination of parameters such as the segregation index, the effective distribution coefficient, and the β stabilizing rate, showed that the genetic trend of the segregation for Mo was larger than V up to 4 wt% in content and was smaller than V over 10 wt% in content. There was a sort of a critical cooling rate under the effect of cooling rate from the β phase in microsegregation generation. The smaller the contents of β stabilizing elements, the stronger the genetic trend of microsegregation. And the trend was lessened with increasing degree of the β stabilizing in the alloys. The genetic trend of microsegregation of Mo and V became stronger in co-existence with Al. Electron absorption images of Ti–Mo alloys showed that the microsegregation was distributed in a

certain small area. V can be presumed to have the same tendency as Mo. (auth)

28637 CURVES OF EVAPORATION RATES VS TEMPERATURE FOR ZINC BINARY ALLOYS AND CADMIUM BINARY ALLOYS. Aida, Teizo; Watanabe, Kazunori (Kumamoto Univ., Japan). J. Jap. Inst. Metals; 36: No. 1, 22-7(Jan 1972). (In Japanese).

Basic studies were made on Zn–Al, Zn–Sb, Zn–Sn, Zn–Pb, Cd–Sb, Cd–Sn, and Cd–Pb alloys, which were heated to their boiling points. The following were illustrated and calculated for the above alloys: curves of evaporation rates W vs temperature T (over the range of about 700 ~ 2000°K); constants B and C of evaporation rates; latent heat of evaporation L_0; and curves of evaporation energy ϵ vs temperature T. Next, the curves of evaporation rates W vs temperature T for the above alloys were compared with the corresponding experimental curves or illustrated curves reported by Burmeister, Kubaschewski, Schneider, and others. The results of comparison showed that both curves were in relatively good agreement at evaporation rates of less than about 20 $g/cm^2 \cdot sec$ in corresponding to the vapor pressure of about 760 mmHg and in the composition ranges of more than (20 ~ 30) wt% zinc in zinc binary alloys, and more than 30 wt% cadmium in cadmium binary alloys. (auth)

28638 PROPERTIES AND HEAT TREATMENT OF Ti–Nb AND Ti–Nb–Al ALLOYS. Moiseev, V. N. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 9-10, 744-7(Sep-Oct 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 9, 35-8(Sep 1971).

Binary Ti alloys with 4, 9, 20, and 50% Nb and ternary alloys with the same percentages of Nb + 3% Al were investigated. Data and information obtained in the investigation are presented concerning microstructure, mechanical properties, and heat treatments. (J.R.D.)

28639 MECHANICOTHERMAL TREATMENT OF Ti–Al–Mo ALLOYS. Khorev, A. I.; Chinenov, A. M.; Martynova, M. M. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 9-10, 748-50(Sep-Oct 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 9, 43-6(Sep 1971).

The effects of alloying on the strengthening of titanium alloys by mechanicothermal treatment (MTT) including quenching, deformation, and aging were studied. Alloys of the Ti–Al–Mo system with a constant aluminum content (3%) and 0.5 to 30% Mo were investigated. It was found that strengthening during cold working depends on the phase composition of the alloy. It is highest for the alloy with 15% Mo, with high plasticity in cold deformation. Cold working leads to greater reduction of uniform elongation than concentrated elongation. With increasing amounts of the alloying element the increase of strength resulting from MTT reaches a peak for the alloy with 15% Mo, which can be recommended for semifinished products and parts subjected to MTT. (J.R.D.)

28640 FRACTURE OF TITANIUM ALLOY VT3-1. Pertsovskii, N. Z.; Shakhanova, G. V. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 9-10, 789-92(Sep-Oct 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 9, 70-5(Sep 1971).

The effects of structure and phase composition of two-phase Al–Mo–Cr–Fe–Ti-base alloy on tensile and mechanical properties of this alloy were investigated. It was found that the macrofractures of this alloy depend only on the type of structure and not on the phase composition. The electron fractographs indicate ductile fracture regardless of the type of structure or phase composition. No relationship was found between the type of fracture and the mechanical properties of the alloy at 20°C. (J.R.D.)

28641 STRUCTURE AND PROPERTIES OF NICKEL ALLOYS FOR CRYOGENIC APPLICATIONS. Sorokina, N. A.; Ul'yanin, E. A.; Tashchilov, V. S.; Rastorgueva, I. A.; Kuborskii, B. N. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 9-10, 823-6(Sep-Oct 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 10, 20-3(Oct 1971).

Nickel-base alloys containing 18% Cr, 1.5% Al, 0 to 20% Fe, and 0 to 5.5% Nb were investigated. It was found that the optimum Fe concentration in weldable alloys intended for use at cryogenic temperatures is 5 to 15% and 2.5 to 3% Nb. (J.R.D.)

28642 STRENGTH AND PLASTICITY OF TITANIUM ALLOYS WITH ZIRCONIUM AT LOW TEMPERATURES. Koshelev, P. F.; Mikheev, V. S.; Nikitin, P. N. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 9-10, 833-5(Sep-Oct 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 10, 30-3(Oct 1971).

The mechanical properties of Ti alloys with Zr up to 30% and their stress sensitivity at −269 to 20°C were investigated. It was found that the ultimate strength and yield strength of titanium alloys increase monotonically with the zirconium content of the alloy. The strength of notched samples is higher than that of smooth samples at all testing temperatures and zirconium concentrations tested. Alloying of titanium with zirconium makes it possible to obtain fairly high strength of alloys without substantially increasing the sensitivity to stress concentrations. Titanium alloys with zirconium are not sensitive to stress concentrations with up to 15% Zr, have satisfactory plasticity, and can be recommended for applications at cryogenic temperatures. (J.R.D.)

28643 EFFECT OF PROLONGED HEATING ON THE PROPERTIES OF MAGNESIUM ALLOYS ML9 AND ML10. Tikhova, N. M.; Blokhina, V. A.; Antipova, A. P.; Vasil'eva, T. P.; Solov'eva, G. G. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 9-10, 887-90(Sep-Oct 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 10, 73-6(Oct 1971).

The effects of heating at 125 to 300°C for ½ to 30,000 h on the microstructure and mechanical properties of Mg-base Nd–Zr alloys were studied. Data and information are presented on chemical composition, mechanical properties, and microstructure. (J.R.D.)

28644 SENSITIVITY OF THE CREEP-RUPTURE PROPERTIES OF WASPALOY SHEET TO SHARP-EDGED NOTCHES IN THE TEMPERATURE RANGE 1000 TO 1400°F. Wilson, D. J. (Univ. of Michigan, Ann Arbor). J. Basic Eng.; 94: No. 1, 13-21 (Mar 1972).

Time-dependent notch sensitivity of Waspaloy was observed at test temperatures from 1000 to 1300°F. Its occurrence in this range was dependent on the heat treatment. "Overaging" eliminated the notch sensitivity. Optimum combination of smooth and notched specimen strengths for material solution treated at 1975°F were obtained by aging 24 hr at 1550°F. Necessary conditions for time-dependent notch sensitivity were (i) the notch specimen loads had to be below the approximate 0.2 percent offset yield strength; and (ii) test data from smooth specimens had to indicate that small amounts of creep used up large fractions of creep-rupture life. No reasons were evident why these criteria will not prove applicable to other alloys. (auth)

28645 COMPUTERIZED EVALUATIONS OF THE RELATIVE ABILITIES OF SEVEN TIME-TEMPERATURE PARAMETERS TO CORRELATE AND EXTRAPOLATE NICKEL ALLOY STRESS-RUPTURE DATA. Raut, P. K.; Clough, W. R. (Georgia Inst. of Tech., Atlanta). J. Basic Eng.; 94: No. 1, 7-12(Mar 1972).

A total of 31 stress-rupture data sets for 28 different nickel-base alloys, including 1153 individual test results, have been treated by graphic methods and computer programs to allow determinations of the relative abilities of Larson–Miller, Manson–Haferd, Sherby–Dorn, Goldhoff–Sherby, Manson–Succop, Conrad and Korchynsky parameters to correlate and extrapolate data. For the correlation of all data the Goldhoff–Sherby and Manson–Haferd methods are attractive, while for extrapolation to longer times some superiority of the Manson–Haferd and Manson–Succop parameters is demonstrated. Overall use of a third order polynomial approximation to Manson–Haferd master curves is recommended, as is the avoidance of external extrapolation. Results are primarily based on modified and original computer programs and standard statistical treatments of data. (auth)

28646 METHOD FOR PREDICTING CREEP DATA FOR COMMERCIAL ALLOYS ON A CORRELATION BETWEEN CREEP STRENGTH AND RUPTURE STRENGTH. Goldhoff, R. M.; Gill, R. F. (General Electric Co., Schenectady, N. Y.). J. Basic Eng.; 94: No. 1, 1-6(Mar 1972).

A method is presented for correlating the creep and rupture strengths of a wide variety of commercial alloys. The ultimate aim of this correlation is to predict design creep properties from rupture data alone. This is of interest because rupture parameter or isothermal rupture curves are frequently the only data available. It is demonstrated that reasonable predictions, useful in design, can be made. The alloys studied range from aluminum base through low alloy and stainless steels and include iron–nickel, nickel, and cobalt-base superalloys. Very long time data for single heats of each of the alloy types has been taken from either the literature or sources willing to make such data available. The

construction is simple, and common techniques for determining scatter in the correlation are developed. The predictions include scatter bands of strain-time data developed from the 15 data sets encompassing all the alloys. It is suggested that some refinement might be gained by studying numerous heats of a single specification material where such data is available. A complicating problem of structural instability arises and is discussed. (auth)

28647 THERMODYNAMIC PROPERTIES OF DILUTE SOLUTIONS OF ZIRCONIUM IN GALLIUM. Rykova, L. N.; Danilin, V. N.; Yatsenko, S. P. (Inst. of Chemistry, Sverdlovsk, USSR). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 9, 1222-4(Sep 1971).

Translated from Zh. Fiz. Khim.; 45: No. 9, 2157-60(Sep 1971).

The thermodynamic properties of zirconium–gallium alloys containing gram atomic fractions of zirconium between 0.005 and 0.05 have been investigated by an emf method in the range 550 to 1170°K. The zirconium concentrations in its saturated solutions in gallium were determined by isothermal heat treatment with subsequent filtration. The thermodynamic properties of liquid dilute solutions of zirconium in gallium were calculated from the results. An equation has been obtained relating the logarithm of the concentration of zirconium in its saturated solution in gallium to the thermodynamic properties of the liquid and solid phases. (auth)

28648 PHYSICOCHEMICAL PROPERTIES OF THE INDIUM–TIN–MERCURY SYSTEM. Yatsenko, S. P.; Sudakov, V. A.; Kozin, L. F.; (and others) (Inst. of Organic Catalysis and Electrochemistry, Alma-Ata, USSR). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 9, 1347-8(Sep 1971).

Translated from Zh. Fiz. Khim.; 45: No. 9, 2375-6(Sep 1971).

The viscosities, electric conductivity, and vapor pressures of In–Sn–Hg alloys were investigated at 293 to 693°K. Results indicate the absence of a ternary eutectic in the system and indicate variation of interactions between components. Results are presented graphically. (J.R.D.)

28649 DIFFERENTIAL ABSORPTION ISOTHERMS OF NITROGEN AND HYDROGEN BY TUNGSTEN. Podvyazkin, Yu. A. (Voronezh Technological Inst., USSR); Kinet. Katal.; 13: No. 5, 1355-6(Sep-Oct 1971). (In Russian).

Differential isotherms have been calculated for the absorption of nitrogen and hydrogen on the surface of tungsten. The data cover the temperature range from 373 to 1,023°K. The form of the differential isotherms depend on the nature of the adsorbate-adsorbent bond and on the temperature. (K.S.W.)

28650 IMPROVEMENTS IN AND RELATING TO DISPERSION-HARDENED METALS AND ALLOYS, AND ARTICLES MADE THEREFROM. Goodwin, Robert James (to Delta Metal (BW) Ltd.). British Patent 1,268,549. 29 Mar 1972. Filed 5 Jun 1969.

It is stated that methods proposed or employed to produce, in substantial quantity, dispersion strengthened metals or alloys have not been entirely successful in achieving results that are theoretically possible. The object of the process described is to provide a method for producing material closer to the theoretical ideal. Particles of the matrix metal, or a compound thereof, are melted in a reducing atmosphere after receiving a coating of a compound from which the dispersoid particles are to be formed, whereby particles of the dispersoid become diffused or dissolved in the matrix, which is then solidified by cooling. The matrix material may be composed of reducible oxides of the required matrix metal, and the dispersoid may conveniently consist of one or more non-reducible oxides, or other inert compound. The solidified particles are, by one or more repetitive operations, treated with a further charge of the compound from which the dispersoid is to be formed, remelted and again solidified. It is preferred to conduct the coating process from solution and fluidization techniques may be employed. The particles may be consolidated or compacted by powder metallurgy techniques. Examples of matrix material quoted are Cu, Ni, Fe, Mo and Co, or alloys thereof, and the dispersoid may comprise MgO, Al_2O_3, CaO, TiO_2, ZrO_2, ThO_2, or rare earth oxides. The process may be batch or continuously operated. A hydrogen atmosphere may be used as reducing agent for the matrix material. (UK)

28651 SOME PROPERTIES OF A EUTECTIC ALLOY IN THE GALLIUM–INDIUM–TIN SYSTEM. Koroleva, N. P.; Fomin, B. A.; Miftakhov, E. Z. Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 32: 211-14(1971). (In Russian).

Methods for the determination of some properties of eutectic Ga–In–Sn alloy with a mp of +10.5°C are described and results given. The coefficient of expansion on solidification is +1.38%; the volume coefficient of expansion on heating in the range 20 to 600°C is 1.32×10^{-4}/deg and in the range 20 to 800°C is 1.28×10^{-4}/deg. The specific heat at 20 to 70°C is 0.0773 cal/g. degC. The viscosity changes from 0.460 cS at 20 to 0.130 cS at 800°C. (Referativnyi Zh.)

28652 TECHNIQUES OF METALS RESEARCH. VOLUME V. MEASUREMENTS OF MECHANICAL PROPERTIES. PART 1. Bunshah, R. F. (ed.). New York; John Wiley and Sons, Inc. (1971). 483p.

The six chapters included contain information on: definitions and concepts; quasi-static mechanical testing techniques; special quasi-static mechanical testing techniques; high strain rate testing; fatigue testing methods; and creep and stress rupture testing. Author and subject indexes are included. (P.C.H.)

28653 TECHNIQUES OF METALS RESEARCH. VOLUME V. MEASUREMENT OF MECHANICAL PROPERTIES. PART 2. Bunshah, R. F. (ed.). New York; John Wiley and Sons, Inc. (1971). 413p.

The eight chapters included contain information on: tests for fracture strength, static to impact; fracture testing of low strength materials; measurements of elastic constants; hardness testing; measurement of residual stresses; acoustic emission effects during mechanical deformation; special techniques for measuring plastic strains; and photoelasticity. Cumulative author and subject indexes are included. (P.C.H.)

28654 EFFECT OF STRESS RATIO ON THE ELEVATED TEMPERATURE FATIGUE-CRACK PROPAGATION OF TYPE-304 STAINLESS STEEL. James, Lee A. (Westinghouse Hanford Co., Richland, Wash.). Nucl. Technol.; 14: No. 2, 163-70(May 1972).

The effect of cyclic stress ratio ($\sigma_{min}/\sigma_{max}$) was examined for Type 304 stainless steel fatigue cycled at 1000°F using the principles of linear-elastic fracture mechanics. Stress ratios varied between –0.15 and 0.75. It was found that at a given value of stress intensity factor range, ΔK, the fatigue-crack growth rate increased with increasing values of stress ratio. However, ΔK did not provide the best basis for correlating crack growth rate results for various stress ratios, and it was found that the term $K_{max}(1-R)^{0.5}$ provided a much better correlation. (auth)

28655 EXPERIMENTAL DETERMINATION OF THE APPARENT ACTIVATION ENTHALPY FOR STRESS RELAXATION OF α-URANIUM. Carvalhinhos, H.; Loureiro, A. P. (Laboratorio de Fisica e Engenharia Nucleares, Sacavem, Portugal). Phys. Status Solidi (a); 9: No. 2, 477-82(16 Feb 1972).

The apparent activation enthalpy, ΔH_{ap}, for stress relaxation of α-uranium was experimentally measured by sudden changes of temperature during relaxation tests. Since these tests also yield the values of the activation volumes, this testing method allows the simultaneous determination of two structure, and stress-dependent parameters that may be related to the stress–strain behavior during constant strain-rate tests. Results for α-uranium at room temperature showed that ΔH_{ap} decreased rapidly from the onset of the constant strain rate plastic deformation up to an applied flow stress of about 40 kp/mm^2. Above this stress the apparent activation enthalpy was found to be nearly constant and equal to (1.21 ± 0.09) eV. (auth)

28656 NEW HIGH STRENGTH, DEEP HARDENABLE TITANIUM ALLOY: Ti–6Al–6V–4Zr–4Mo. Heitman, G. H. (Wyman-Gordon Co., North Grafton, Mass.). J. Metals; 23: No. 5, 37-42(May 1971).

With the increased demand for titanium in large structural components for such applications as the supersonic transport and deep submergence vehicles there is a requirement for high strength deep hardening alloys. The present beta type titanium alloys offer a depth hardenability up to 6 in., and generally have high densities and relatively low ductilities. Alpha + beta alloys such as Ti 6Al-6V-2Sn show high strength capability; however, strength decreases significantly in section sizes over 1 in. A new alpha–beta alloy, Ti 6Al-6V-4Mo-4Zr, presently under development, offers relatively high strength in sections up to 6 in., somewhat lower density than the beta alloys, adequate ductility in three directions, and exceptionally good fracture toughness. The development of the new alpha–beta titanium alloy is described and a comparison is made with presently available high strength titanium. (auth)

Radiation Effects

Refer also to abstracts 28684, 29990, 30011, and 30224.

28657 (COO-1799-8) COALESCENCE OF HELIUM BUBBLES IN ALUMINUM. Chen, K. Y.; Cost, J. R. (Purdue Univ.,

Lafayette, Ind. School of Materials Science and Metallurgical Engineering). Mar 1972. 41p. Dep. NTIS.

The formation and coalescence of helium bubbles in aluminum with annealing at 550°C is examined experimentally using electrical resistivity and electron microscopy. Results are compared with those obtained by computer simulation in order to test models based upon various mechanisms for bubble motion. The computer method previously developed is extended from an ideal to a Van der Waals gas and both upper and lower limiting values of the surface energy of aluminum are considered. These factors are shown to significantly affect the kinetics of coalescence. Comparison of experimental and computer results indicates that the motion of helium bubbles in aluminum is not surface diffusion limited and that it is consistent with the facet nucleation-limited mechanism originally proposed by Willertz and Shewmon. (auth)

28658 (COO-3171-8) ELECTROMIGRATION STUDY OF VOID KINETICS IN METALS. Annual Progress Report. Ho, Paul S. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). Mar 1972. Contract AT(11-1)-3171. 8p. Dep. NTIS.

Research results are described on electron effects on void formation in He preinjected Al films, dislocation loop formation in electron irradiated Al film, and bubble formation in He ion irradiated Au films. (J.R.D.)

28659 (GKSS-71/E/15) IRRADIATION INVESTIGATIONS ON A REACTOR PRESSURE VESSEL STEEL OF HIGH TENSILE STRENGTH. Intermediate Report Condition, July 1, 1971. Schmitt, F. J. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (West Germany)). 1971. 24p. (In German). Dep. NTIS (U. S. Sales Only).

Neutron irradiation was performed on pressure vessel steel with increased nickel content and curves for notch-resistance were determined. Predominantly, irradiation was conducted at 300°C. Results showed expected behavior and promised excellent applicability of these steels for pressure vessels, especially for the EFDR. Presently, experiments are being conducted at irradiation temperatures of 220°C and with modified FDR steels; results should be available soon. (tr-auth)

28660 (N-71-38279) CORRELATION OF IRRADIATION DATA USING ACTIVATION FLUENCES AND IRRADIATION TEMPERATURE. Lynch, John H. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov 1971. 16p. (NASA-TN-D-6564; E-6493). NTIS.

A method of direct correlation of radiation damage with time-integrated activation of neutron dosimeters is described. The method is tested by using a consistently defined set of nil-ductility transition temperature data for A302-B ferritic steel and is compared with a correlation representative of damage function techniques. For the data studied, the new method is as accurate as the damage function method and its advantages over this method are pointed out. Also, the effect of irradiation temperature on damage is treated. (auth) (STAR)

28661 (N-72-11986) SUBSYSTEM RADIATION SUSCEPTIBILITY ANALYSIS FOR DEEP-SPACE MISSIONS. West, Wm. S.; Poch, W.; Holmes-Siedle, A.; Bilsky, H. W.; Carroll, D. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Nov 1971. 179p. (NASA-TR-R-371; G-1029). NTIS.

Scientific, unmanned spacecraft on mission to Jupiter and beyond will be subjected to nuclear radiation from the natural environment and onboard nuclear power sources which may be harmful to subsystems. These environments are described and practical considerations to ensure confidence that the spacecraft's materials and subsystems will withstand the effects of anticipated radiation are discussed. Degradation mechanisms are also discussed. (auth) (STAR)

28662 EFFECTS OF NEUTRON IRRADIATION ON G. P. ZONES AND PRECIPITATES IN TERNARY ALUMINUM ALLOYS. Liu, Kuo-shung; Kawano, Osamu; Yoshida, Hiroyuki; Murakami, Yotaro (Kyoto Univ.). J. Jap. Inst. Metals; 36: No. 1, 75-81(Jan 1972). (In Japanese).

In order to investigate the effects of neutron irradiation on the behavior of spherical Guinier-Preston (G.P.) zones and intermediate precipitates, the measurements of x-ray small angle scattering and electrical resistivity were carried out on the ternary Al-2.8 at% Zn-1.4 at% Mg and Al-5 at% Ag-5 at% Zn alloys. Through the measurements of the scattering intensity before and after irradiation at a low temperature (~10°K) and at an inpile temperature (~80°C), it was found that the sizes of G.P. zones and intermediate precipitates after irradiation decreased, while the size distribution became wider and volume fraction became larger than those before irradiation. From the measurements of electrical resistivity it was found that the precipitation of the intermediate phase in an Al-Zn-Mg alloy was delayed by irradiation. The results suggest that during irradiation at a low temperature the spherical G.P. zones and intermediate precipitates must be partially broken up by collision cascades and displacement spikes, not by thermal resolutions. (auth)

28663 CURRENT STIMULATION OF RADIATION-PLASTIC DEFORMATION OF METAL. Spitsyn, Vikt. I.; Troitskii, O. A.; Glazunov, P. Ya. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 201: No. 2, 324-7(11 Nov 1971). (In Russian).

It had previously been shown that current pulses of 10^2 to 10^3 A/cm^2 lasting for about 10^{-4} s evoke sudden changes in the cold plastic deformation of metals. The effects of electrons from a particle accelerator injected into the metal on the peak height of electroplastic deformation were studied. The experiments were conducted with monocrystals of Zn, Sn, and Pb, which were elongated, while under the simultaneous influence of current and radiation. Experimental temperatures ranged from 20 to -196°C. Relaxation of the loading was also recorded for various regimes: irradiation alone, irradiation + pulsed current, pulsed current alone, and "controls." (K.S.W.)

28664 IN-PILE DIMENSIONAL CHANGES OF ZIRCALOY-4 TUBING HAVING LOW HOOP STRESSES (LIGHT WATER BREEDER REACTOR DEVELOPMENT PROGRAM). Daniel, Ray C. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Technol.; 14: No. 2, 171-86(May 1972).

Diameter and length changes have been measured for 0.25 to 0.30 inch OD fuel rods having Zircaloy-4 cladding thicknesses from 17 to 22 mils. The external coolant pressure (2000 psi) yielded hoop stresses in the range of 11,000 to 15,000 psi. Short rods (6 to 11 inch) were irradiated in an ETR loop (peak fast flux $\cong 1.5 \times 10^{14}$ nv) while long rods (~10 feet) were irradiated in a NRX loop (2.5×10^{13} nv). A method has been developed for separating components of the diameter and length changes caused by Zircaloy growth, external pressure, and fuel-clad interactions. It is concluded that the diameter shrinkages of the short rods (up to about 1 mil, 0.4%) were caused entirely by the external pressure. However, those of the long rods (up to ~2 mils, 0.8%) were strongly dependent on fuel-clad interactions, with large diameter shrinkages being accompanied by large length increases (up to about 0.7%). A calculational method based on the CYGRO computer program is used to simulate such behavior for long rods. (auth)

Other Materials

Refer also to abstracts 29980, 29982, 29983, 30014, 30093, 30123, and 30437.

28665 (BNL-50313) CONCRETE-POLYMER MATERIALS DEVELOPMENT, A GOAL-ORIENTED PROGRAM. Lecture Series Number 105. Steinberg, Meyer (Brookhaven National Lab., Upton, N. Y.). 6 Oct 1971. Contract AT(30-1)-16. 37p. Dep. NTIS.

The principles of applied research are briefly reviewed, and the concrete-polymer materials development program is described in detail as an example of goal-oriented research. In this program the ancient technology of concrete is mated with the recent technology of polymers. The composites are classified as polymer impregnated concrete (PIC), polymer-cement concrete (PCC), cementless polymer-concrete (PC), and concrete with coating in depth (CID). The tasks in the program include monomer survey, process technology, measurement of properties, applications development, economic evaluation, and administration. The materials obtained and their characteristics are described. The durability and structural strength of concrete-polymer are much improved over those of conventional concrete. A number of government agencies, industrial associations, universities, and foreign firms have taken up this research, and preliminary marketing evaluations are in progress. Major potential applications include piping, building panels, bridge decking, distillation vessels, and mine supports. Costs vs product value are briefly discussed. (auth)

28666 CHANGES IN THE ELASTIC PROPERTIES OF GLASSES IN THE SYSTEM As_2S_3-As_2Se_3 UNDER THE EFFECT OF PENETRATING RADIATION. Domoryad, I. A.; Kolomiets, B. T. (Ioffe Inst. of Physics and Tech., Leningrad). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 9, 1436-7(Sep 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 9, 1620-1(Sep 1971).

Studies were made on the effects of γ irradiation on the elastic properties of glass of the system $As_2S_3-As_2Se_3$ by the method of shear vibrations. The characteristic of the radioinduced changes in the mechanical properties was the square of the frequency of free oscillations, determined within 0.04 %. On the basis of ideas on the polymeric structures of the glasses, it can be assumed that during irradiation the structures of the glasses are compacted, and this increases the shear modulus and reduces the linear dimensions of the irradiated specimens. (P.C.H.)

28667 HIGH PERFORMANCE REINFORCEMENTS FOR ADVANCED STRUCTURAL COMPOSITES. Dauksys, R. J. SAMPE Quart.; 3: No. 2, 1-6(Jan 1972).

The status of high performance continuous filaments for reinforcing nonmetallic matrices is discussed along with other reinforcements considered particulate by virtue of aspect ratio (length-to-width and diameter-to-thickness) or micro size. The intention is to provide background information on reinforcements relating to materials aspects such as chemistry, processing, and fracture, as well as current data reflecting translation of reinforcement properties to composites. Also, new and anticipated fiber reinforcements shall be mentioned. Since boron and graphite fibers have gained the most prominent positions as candidate reinforcements for advanced aerospace hardware applications, the merits, disadvantages, and characteristics of those materials are emphasized. (auth)

28668 STATUS OF ORGANIC MATRICES IN ADVANCED COMPOSITES. A PERSONALIZED VIEW. Petker, Ira. SAMPE Quart.; 3: No. 2, 7-21(Jan 1972).

Considerations relative to matrices in structural composites occur in three categories: their influence upon mechanical behavior, their processability, and their behavior in adverse environments. Premises from which each of these considerations can be reviewed in a generalized manner are developed and the current status of resins are related to these premises. (auth)

28669 MANUFACTURING METHODS FOR ADVANCED COMPOSITES. Cornsweet, Tobey M. SAMPE Quart.; 3: No. 2, 28-33(Jan 1972).

Increasing emphasis is being placed on improved manufacturing methods for advanced composites. Major changes are taking place in almost every area of fabrication. Aspects of production manufacturing are discussed, including processes in current use, new activities that will make near term changes in the manufacturing process, and future processing changes that should impact production manufacturing methods in the 1974 to 1975 time period. (auth)

28670 ADVANCED COMPOSITE APPLICATION TO SPACECRAFT AND MISSILE COMPONENTS. Forest, J. D.; Hertz, J.; Christian, J. SAMPE Quart.; 3: No. 2, 34-44(Jan 1972).

The unique properties of both organic and metal matrix composites are discussed. The applications in spacecraft and missile components which take advantage of these properties are presented. (auth)

28671 APPLICATIONS OF ADVANCED COMPOSITES FOR AIRCRAFT. June, R. R.; Kelly, J. B. SAMPE Quart.; 3: No. 2, 58-66(Jan 1972).

Applications of both boron/epoxy and graphite/epoxy on specific aircraft projects are discussed. The future potential of advanced composites for aircraft is presented, with a comparison of the economic risks and advantages available to the user. (auth)

28672 OPTIMIZING COMPOSITE PROPERTIES. Mullin, J. V.; Mazzio, V. F. SAMPE Quart.; 3: No. 2, 22-7(Jan 1972).

Although new fibers and matrix materials are continually being developed for use in advanced composites, there is more emphasis on optimizing overall performance than maximizing the strength of each constituent. The role of the matrix and interface in the failure process is given considerably more attention now than in the earlier stages of composite materials research. Some of the fundamental considerations in optimizing composite performance are reviewed with primary emphasis on matrix and interface effects. (auth)

28673 HIGH-TEMPERATURE STRENGTH OF JOINTS OF GRAPHITE MATERIALS. Anikin, L. T.; Kravetskii, G. A.; Dergunova, V. S. Svar. Proizv.; No. 1, 18-19(Jan 1972). (In Russian).

A method of joining graphite materials by the use of an intermediate carbide-forming interlayer is discussed. It is shown that the high-temperature strength of the brazed joint is a function of the interaction of the molten solder with the graphite, the depth of its penetration in the pores of the material, the newly formed phase composition, and the strength of the graphite. Results of comparison tests on graphite specimens bonded by a zirconium interlayer indicate that the strength of the brazed specimens heated above the melting temperature of zirconium is 30 to 35% higher than that of specimens heated below this temperature. The tensile strength of the brazed joints increases with the penetration depth of the solder up to a specific value (2 to 2.5 mm) and then remains constant. The failure which had occurred in the specimens in tensile tests at 2000°C was found to be along the graphite outside the brazing zone. It is suggested that brazing of large-pore graphite be done with solders capable of forming (on contact) carbon saturated fusions under compression to afford maximum solder penetration and complete carburization to a composition close to stoichiometric. The study includes test data on solders from hafnium, molybdenum, and tungsten. (JPRS)

28674 ACTIVATION ENERGIES FOR CREEP OF PYROLYTIC AND GLASSY CARBON. Langdon, T. G. (Univ. of Southern California, Los Angeles). Nature (London) Phys. Sci.; 236: No. 65, 60(27 Mar 1972).

In an investigation of the high temperature (2500° to 2900°C) creep behavior of glassy carbon, apparent activation energies for creep in the range 306 to 382 kcal/mole were obtained by Fischback (Carbon; 9: 193(1971)), and it is stated that these values are unexpectedly high for a non-graphitizing carbon with a disordered structure, especially when compared with the activation energies of 250 and 260 reported for creep and graphitization, respectively, of pyrolytic carbon. The present communication examines whether the temperature dependence of the shear modulus may give rise to an important contribution to the activation energy; calculations suggest that this may be so. (UK)

28675 POSSIBLE APPLICATION FIELDS OF RADIATION INDUCED POLYMERIZATION OF POLYESTER RESINS AND OTHER POLYMERS. Pesek, M. (Vyrobu a Vyuziti Radioisotopu, Prague). Radioisotopy; 13: No. 2, 361-9(1972). (In Czech).

Unsaturated polyester resins alone or in combination with vinyl or allyl monomers can be used for impregnation of various porous materials. The curing of the incorporated impregnation mixture requires lower radiation doses than when polymerizing the impregnation mixture alone. By this method the properties of impregnated wood, paper, concrete, porous ceramics, and porous metal products can be improved. Discussions are included on the application possibilities of radiation induced polymerization of unsaturated polyester resins alone or in mixture with a greater amount of other vinyl monomers in porous materials with the aim of improving the properties of some materials and products. (auth)

28676 QUALITY ASSURANCE FOR PROTECTIVE COATINGS APPLIED TO NUCLEAR FACILITIES. ANSI N101.5.7-1972, Rev. 9. New York; American National Standards Institute, Inc. (1972). 38p.

This standard provides a common basis for the quality assurance of protective coatings applied to nuclear facilities. Quality assurance, as covered by this standard, comprises all those planned and systematic actions necessary to provide specified documentation and adequate confidence that shop and field coating work for nuclear facilities will perform in accordance with the specified requirements. The subjects covered include: the application and use of this standard; general requirements; coating materials; surface preparation of substrates; application of coating systems; coating inspection; and quality assurance documentation. (L.C.L.)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

Accountability and Safeguards

Refer also to abstracts 27743, 27761, 28119, 28210, and 28275.

28677 (ANL-7906) FOUR PASSIVE ASSAY TECHNIQUES APPLIED TO MIXED-OXIDE FUEL. Beyer, N. S.; Perry, R. B.; Brandenburg, R. W.; Lewis, R. N. (Argonne National Lab., Ill.). Jan 1972. Contract W-31-109-eng-38. 30p. Dep. NTIS.

It was demonstrated that four different passive nondestructive assay techniques could be successfully used to measure an inventory of mixed-oxide $(Pu,U)O_2$ fuel rods. The techniques included: calorimetry, neutron-coincidence counting, and gamma-ray counting using NaI(Tl) detection or an automated GeLi detection system. A thorough program of destructive measurements was also conducted, and the numerical results obtained nondestructively were compared with the destructive analyses to evaluate the reliability of the former. Results of the comparison indicated no significant difference for three of the techniques and a difference of approximately 0.5% relative, for the neutron-coincidence-counting technique. The inventory consisted of two loadings of approximately 12,000 and 6000 rods each and contained 15 and 30 wt %, respectively, plutonium oxide with an isotopic content of about 88% $^{239+241}Pu$ and 11.5% ^{240}Pu. Results demonstrated advantages and limitations of each technique when applied to a real fuel-inventory measurement problem and indicated the precision and reliability that can be expected. (auth)

28678 (WASH-1170) BIBLIOGRAPHY OF NON-DESTRUCTIVE ASSAY METHODS FOR NUCLEAR MATERIAL SAFEGUARDS. Edwards, Raymond R.; Gritton, G. Vance; Higinbotham, W. A. (Division of Nuclear Materials Security (AEC), Washington, D. C.). 28 Feb 1972. 87p. GPO $1.00.

The bibliography contains title, author and abstract for each of about 400 references on non-destructive nuclear material measurement methods or instruments. The abstracts are classified into sixteen categories and listed chronologically within each category. Most of the abstracts were taken from Nuclear Science Abstracts. The period covered is 1954 through 1969. Categories include: calorimetry, gamma-ray spectrometry, active and passive neutron measurements, radiography, x-ray fluorescence, and general reports on safeguards techniques. (auth)

28679 INTERNATIONAL SAFEGUARD INSPECTIONS. Imai, Ryukichi. Tokyo; Asahi Shimbun (1971). 273p. (In Japanese).

International safeguards measures for preventing nuclear proliferation were studied. Past and current safeguards concepts by individual countries are reviewed, and the technical and political situations are described. The international safeguards system is meant to check on whether countries are producing nuclear weapons insidiously; but no methods for this are technically possible. Therefore, it is proposed that a certain international organization statistically examine safeguards data collected by individual countries. The international safeguards inspections involve both technology and politics. With the ever advancing technology in many parts of the world, it is absolutely necessary to properly regulate the menace of nuclear proliferation. (Japan)

28680 PRINCIPLES OF CRITICALITY SAFETY IN PROCESSING AND HANDLING FISSILE MATERIALS. DIN 25 403-1970. Berlin; Fachnormenausschuss Kerntechnik (1970). 1p. (In German).

The most important recommendations related to safety or accident prevention in the planning of facilities for producing, processing, and fabricating of irradiated and nonirradiated nuclear materials, in the performance of related technical processes, and in the storage of fissile materials are summarized. These recommendations are valid for quantities of fissile material for which criticality is possible. The special problems involved in the transport of nuclear materials are not covered. Information is included on preventive safety measures, criticality assessment, shielding requirements, construction of facilities, process control, materials accounting requirements, and the movement of nuclear materials within a facility from the time it is received until it is shipped. (L.C.L.)

28681 PHYSICS OF NUCLEAR MATERIALS SAFEGUARDS TECHNIQUES. Gozani, Tsahi (Gulf Radiation Tech., San Diego, Calif.). Nucl. Technol.; 14: No. 1, 8-19(Apr 1972).

The active nondestructive assay techniques which are being used or developed are briefly reviewed. The basic physical principles of the two main techniques, the first one employing photons (i.e., gamma radiation with bremsstrahlung spectrum) and the second one employing neutrons to induce characteristic reactions, mainly fissions, are discussed. The difference in the basic nuclear reactions of photons and neutrons with matter is discussed. There is a large variety of active nondestructive techniques. They differ in the type of source employed, the type of interrogating particles used, the types of induced radiation detected, the type of detection schemes and equipment utilized, and in over-all versatility, efficiency, and cost. The fundamental nuclear and reactor physics problems discussed above are common to all the techniques. However, there are large differences in the severity of the implications of these problems to the various techniques. The current most outstanding problem is the effect of the neutron slowing down and moderation by the matrix materials (especially if they are of low-Z) in the assayed samples. This problem pertains mainly to the neutron induced techniques, and, to a lesser extent, to photoinduced techniques when the observed signatures are prompt or delayed neutrons. So far, most of the proposed methods for reducing or correcting for neutron moderation effects have been limited to relatively simple, though important configurations, such as samples with homogeneously distributed moderating materials and low density fissile and other absorbing materials. Another basic problem which pertains mostly to the assay of large samples, is the attainment of a uniform irradiation or rather a uniform response to nuclear material located throughout the sample. This has been achieved using a well collimated beam of bremsstrahlung radiation and programmed scanning of the sample. However, the use of broad beams of interrogating neutrons or photons, which allow much faster measurement requires further study. Another current important problem of vital importance to all assay techniques is the question of standards. Since all techniques are based on comparisons to "known" standards, an effort is warranted in the study of the requirements for standards, their preparation, and actual detailed measurements. The availability of good standards could minimize the difficulties caused by the problems mentioned in this work. (auth)

Disposal and Storage

Refer also to abstracts 27827, 27887, and 28556.

28682 THERMAL ASPECTS OF BURYING RADIOACTIVE WASTES IN BEDDED SALT. Cheverton, R. D.; Turner, W. D. (Oak Ridge National Lab., Tenn.). Power Eng.; 76: No. 4, 48-50(Apr 1972).

Two important types of radioactive wastes in terms of potential for contaminating the biosphere are concentrated fission products and transuranic elements and alpha-contaminated materials. It is estimated that by the year 2000 there will be 770,000 ft^3 of concentrated high-level waste and 27,000,000 ft^3 of compacted alpha waste. Methods for waste disposal are discussed. It was concluded that the most effective permanent disposal of radioactive wastes is through burial in salt deposits. The wastes would be concentrated and solidified before burial. The proposed site for waste burial at Lyons, Kansas is described. A thermal analysis of the waste repository is presented. Considerations in the analysis include factors in heat removal and designing for heat removal. Results of field experiments at the Lyons, Kansas site conducted from 1963 to 1968 are presented. (R.C.K.)

28683 IN SITU INCORPORATION OF NUCLEAR WASTE IN DEEP MOLTEN SILICATE ROCK. Cohen, Jerry J.; Lewis, Arthur E.; Braun, Robert L. (Univ. of California, Livermore). Nucl. Technol.; 14: No. 1, 76-88(Apr 1972).

A method for disposing of nuclear-reactor wastes by in-situ incorporation in molten silicate rock is presented. In this method, liquid wastes are injected into a deep underground chimney and allowed to self-boil. The resulting steam is processed at the ground surface and recycled into a closed system. When waste addition is terminated, the chimney is allowed to boil dry, thereby solidifying the waste. The heat generated by the radioactive waste then melts the surrounding rock, which dissolves the waste. Finally, the rock refreezes, trapping the radioactivity in an insoluble rock matrix deep underground. This method has significant environmental and economic advantages over previously proposed methods. (auth)

Handling Equipment and Procedures

28684 (CEA-N-1482) MACROGRAPHY APPARATUS FOR A VERY HIGH-ACTIVITY CELL. Vignesoult, Nicole; Houdaille, Brigitte; Roussel, Emile; Fremiot, Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec 1971. 26p. (In French). Dep. NTIS (U. S. Sales Only).

The problems specific to the macrography of irradiated samples were solved by the development of an apparatus based on the following principles: ease and rapidity of manipulation by predirecting the different lightings (normal, oblique, annular and flash); optical resolution equivalent to that of a Reichert type macrography apparatus: 120 lines per mm; image obtained, for an object 31 mm in diameter, enlarged 2 to 10 times on the 18 × 24 ground glass screen of the photographic chamber; setting in a microscope type cell (15 cm of Pb). This apparatus is particularly well suited to the work in high activity laboratories and the images obtained are of good quality. (France)

28685 APPARATUS FOR SELECTIVELY EXAMINING RADIOACTIVE SAMPLES. Hof, Jan Sjouke; Otten, Gerardus (to U. S. Philips Corp.). U. S. Patent 3,654,472. 4 Apr 1972. Priority date 2 Sep 1967, Netherlands.

An apparatus having a series of movable trays for holding a plurality of radioactive samples, and for transporting each tray and each sample carried thereon to a shielded detection unit for examination is described. (Official Gazette)

28686 DEMOUNTABLE CELLS FOR SHIELDING RADIOACTIVE ELEMENTS. Fedi, Letto; Glachet, Charles. U. S. Patent 3,644,737. 22 Feb 1972. Priority date 28 Dec 1967, France.

A shielded cell is described for the safe manipulation of objects or materials which present hazards arising from radiation or other causes and which are to be isolated from the environment. The construction of the cell entails the use of a small number of different types of standard reversible elements of maximum size which are designed for reuse and are provided in particular with penetrations located in accordance with operating requirements. The elements to be interassembled by known means for ensuring compliance with shielding requirements are essentially endowed with shapes related to a square unit of which one side is a suitable multiple of the common thickness of said elements, to rectangular elements each having a length corresponding to one side of said square unit of a width corresponding to simple submultiples thereof, a corner-post provided with means for assembly and fastening at right angles, and rectangular elements adapted to carry overlap slabs for covering said cells. (Official Gazette)

28687 FAIL SAFE INSTALLATION OF A VACUUM SYSTEM FOR SPUTTERING APPLICATIONS IN A GLOVE BOX. Coleman, W. J. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Advan. Instrum.; 25: Pt. 4, 803.1-6(1970).

From twenty-fifth annual conference of the Instrument Society of America; Philadelphia, Pa. (26 Oct 1970).

In the development of a method for containing Po as an isotopic heat source, the hollow microsphere concept was originated. To make this concept work, many new fabrication processes were required. One of these processes involved sputtering and vacuum evaporation techniques. Due to the biological hazard, it was mandatory that the equipment be operated in a fail safe condition. The procedures involved in installing a vacuum system into a radiation glove box and the modifications necessary for installing a sputtering unit in this box are described. A major consideration in the installation of the vacuum system and sputtering unit in the radiation glove box was to provide a mechanism so that any malfunction would result in immediate shutdown. That is, if the power or any one of the components failed, the unit would shut down in such a way that no release of radioactive material would occur. The box in normal operation is maintained at a pressure of −1 in. of water. All mechanisms fail in such a manner as to maintain this negative pressure in the box. The interlock system has been in operation for over 6 months. During this period, it has shut the system down several times, due to abnormal glove box pressure and inadequate water flow, with no adverse effects. (auth)

28688 SYSTEM FOR THE REMOVAL OF TRITIUM FROM EXHAUST AIR. Heertje, I.; Koch, G. K.; Geheniau, M. R. M. (Unilever Research, Vlaardingen, Netherlands). J. Label. Compounds; 8: No. 1, 95-8(1972).

A high-efficiency filter can be used to prevent undue amounts of radioactivity in the exhaust of a radioisotope laboratory. However, tritium gas is not retained by these filters, therefore, other methods must be applied. A system was developed in which hydrogen gas from glove boxes is oxidized by a Deoxo unit and most of the activity of the water is removed by spray scrubbers. Finally the air is injected into the central exhaust shaft of the laboratory. (auth)

28689 SOME EFFECTS OF WATER SPRINKLERS ON ARRAY CRITICALITY SAFETY ANALYSES. Handley, G. R. (Union Carbide Corp., Oak Ridge, Tenn.). Nucl. Technol.; 14: No. 1, 71-5(Apr 1972).

The criticality safety of water-sprinkled arrays of enriched uranium metal on 20-inch center-to-center spacing was investigated using KENO, a multigroup Monte Carlo criticality calculation program. The effects of array size and unit apparent density on the optimum-density interspersed water moderation were analyzed. It was shown that larger arrays of enriched uranium require a lower density of interspersed hydrogenous moderator for optimum moderation than do similar smaller arrays. Also, it was shown that when the density of dry uranium metal units is decreased from full density without changing the mass or the center-to-center spacing of the units, while maintaining optimum interspersed hydrogenous moderation, the neutron multiplication of the array at first decreases, then increases beyond that of the array of full-density units. The initial decrease of the neutron multiplication of the array may not be true in general for all arrays. (auth)

Transportation

Refer also to abstract 28424.

28690 (ORNL-TM-3713) DROP, PUNCTURE, AND THERMAL TESTS PERFORMED ON THE FOAMGLAS SHIPPING CONTAINER, DOT SPECIAL PERMIT NO. 5795. Klima, B. B.; Shappert, L. B. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 58p. Dep. NTIS.

The Foamglas shipping container, which has been issued Department of Transportation Special Permit No. 5795, was subjected to the drop, puncture, and thermal tests, which are part of the "Hypothetical Accident" conditions of the AEC Appendix 0529. This container passed these tests without damage to the inner container and no damage that would result in loss of radioactivity. The polyethylene bottle inside the inner container was not damaged by the thermal test. Water contained in the polyethylene bottle reached a maximum temperature of 158°F 400 min after the start of the thermal test. (auth)

28691 CONTROL AND CLASSIFICATION OF ISOTOPE PACKAGING TYPE H 003 A. Repas, L.; Golder, F. (MTA Izotop Intezete, Budapest). Izotoptechnika; 14: No. 10, 437-51(Oct 1971). (In Hungarian).

Results of a survey of control requirements, devices, and methods for isotope packaging are presented. (J.R.D.)

PARTICLE ACCELERATORS

Design, Development, and Operation

Refer also to abstracts 28237 and 29640.

28692 (INS-TH-71) SUPERCONDUCTING ELECTRON LINEAR ACCELERATOR WITH ENERGY OF 5 TO 40 GeV. Katayama, Takeshi (Tokyo Univ. (Japan). Inst. for Nuclear Study). Jul 1971. 34p. (In Japanese). NTIS (U. S. Sales Only).

Characteristic features of superconducting linear accelerators (SCL) are explained, and a proposal for a superconducting linac with an energy of 5 to 40 GeV is presented. The beam energy is 5 to 40 GeV with a field gradient of 30 MeV/m. The frequency of the RF power is 1350 MHz. The temperature of the cavity must be as low as possible and less than 2°K, and the peak current designed is 100 μ A. The type of RF structure is standing wave. Other parameters such as filling time, beam pulse length, duty cycle, energy stability and so on are also presented. (Japan)

28693 (RDT-C-15-4-T(2-72)) SELF-POWERED COBALT-EMITTER NEUTRON DETECTOR. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Feb 1972. 18p. RSO.

The requirements for self-powered cobalt-emitter neutron detectors for use in core in PWR facilities where the thermal neutron-to-gamma (n/γ) ratio is 10^5 n/cm^2/sec/R/hr or higher are defined. The standard is written for a detector n/γ signal ratio of 4/1 minimum. (auth)

28694 MEDICAL CYCLOTRON FACILITY. Radiaz. Alta Energ.; 10: No. 3, 149-58(Jul 1971). (In English and Italian).

Some characteristics of the Minicyclotron MC-20 AVF cyclotron for medical uses are described. Protons, deuterons, helium-3, and alpha particles can be accelerated at fixed or variable energies. The production of short-lived nuclides for radiodiagnosis, activation analysis, and the production of neutrons for radiotherapy are briefly discussed. (W.H.K.)

28695 PROCEEDINGS OF THE 8th INTERNATIONAL CONFERENCE ON HIGH-ENERGY ACCELERATORS, CERN 1971. Conference Held at Geneva, 20-24 September 1971. Blewett, M. Hildred; Vogt-Nilsen, Nils (eds.). Geneva; European Organization for Nuclear Research (1971). 637p. Sw. Fr. 50.-. (CONF-710908).

Separate abstracts were prepared for 122 of the 131 papers presented. The remaining 9 papers were previously included in NSA and can be found through a cumulative report number under CONF-710908. (W.H.K.)

For abstracts of individual papers see: 28259, 28696–28717, 28725–28741, 28748–28761, 28766–28790, 28800–28831, 28838–28847, and 29129.

28696 NAL PROTON SYNCHROTRON. Wilson, R. R. (National Accelerator Lab., Batavia, Ill.). pp 3-13 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The NAL proton synchrotron is described, and the construction and operation status is outlined. Topics include the linac, booster synchrotron, main accelerator, alignment, power supplies, beam-abort system, controls, extraction system, proton switchyard, experimental laboratories (meson, neutrino, and proton), and some problems. (W.H.K.)

28697 STATUS REPORT ON THE 76 GeV IHEP ACCELERATOR. Ado, Yu. M.; Zhuravlev, A. A.; Zaitsev, V. I.; (and others) (inst. for High Energy Physics, Serpukhov, USSR). pp 14-16 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Information on the development, operation, and status of the 76-GeV IHEP accelerator is given. (W.H.K.)

28698 EUROPEAN 300 GeV PROGRAM. Adams, J. B. (CERN, Geneva). pp 25-31 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The history of events leading up to the decision of the CERN Council to go ahead with the European 300 GeV Programme in February, 1971, is described. A brief description of the main characteristics of the Programme is given introducing the idea of an accelerator complex capable of future developments on one site. Also, progress with the Programme since February is reported. (auth)

28699 SUPERCONDUCTING SYNCHROTRON MAGNETS: PRESENT STATUS. Smith, P. F. (Rutherford High Energy Lab., Chilton, Eng.). pp 35-46 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The progress that has been made and the problems that still remain in the development of pulsed superconducting synchrotron magnets are reviewed. (W.H.K.)

28700 SUPERCONDUCTING RING ACCELERATORS. Green, G. K. (Brookhaven National Lab., Upton, N. Y.). pp 47-50 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

An attempt is made to survey the status and prospects of ring accelerators employing superconducting magnets. (auth)

28701 SOME THEORETICAL ASPECTS OF RF SUPERCONDUCTIVITY. Turneaure, J. P. (Stanford Univ., Calif.). pp 51-60 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The present understanding of rf superconductivity is discussed with emphasis on topics that relate to accelerating devices. Topics include relation of experiment to theory, the low field BCS surface resistance, the residual surface resistance, nonlinear effects (surface resistance and frequency tuning effects), rf critical magnetic fields (type I and type II superconductors), and electron loading effects (electron field emission and electron multipactoring). (40 references) (W.H.K.)

28702 PRELIMINARY STUDIES FOR A 1000 GeV SUPERCONDUCTING EXTENSION OF THE EUROPEAN ACCELERATOR. Arendt, F. (Univ., Karlsruhe, Ger.); Green, M. A.; Harold, M. R.; (and others). pp 171-6 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Design problems for a 1000 GeV superconducting (S/C) synchrotron at CERN are outlined. (auth)

28703 STATUS REPORT ON THE COLLECTIVE LINEAR ACCELERATOR AT DUBNA. Sarantsev, V. P. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 391-6 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Topics include experiments on the acceleration of α particles using the model of the collective accelerator, development of the high-current induction electron linear accelerator, and status of the ring compressor and superconducting accelerating section. (W.H.K.)

28704 GARCHING ELECTRON RING ACCELERATOR EXPERIMENTS. Schlueter, A. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). pp 403-7 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The Garching ERA experiment consists of a field emission electron source, an electrostatic accelerator (up to 2 MeV) and a fast three-stage magnetic compressor. Compression of rings of up to $2-10^{12}$ electrons to energies of 12.6 MeV has been achieved. A compressor II for performing roll-out experiments is under construction. (auth)

28705 STATUS REPORT ON ERA: KARLSRUHE. Dustmann, C.; Heinz, W.; Hermann, H.; (and others) (Kernforschungszentrum, Karlsruhe, Ger.). pp 408-14 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The first stage of the Karlsruhe experimental ERA program is described. Preliminary results with compressed electron rings are presented and discussed. Future plans are submitted. (auth)

28706 SOME PROBLEMS OF CREATION OF COLLECTIVE ACCELERATORS. Derendyaev, Yu. S.; Iovnovich, M. L; Ivanov, I. N.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). pp 456-60 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The question of the formation of the magnetic field necessary for extraction of the electron-ion ring from the setup in which it is created to the accelerating system of the collective accelerator by means of the "computer + display" system is considered. The requirements for tolerances on the magnetic field of the initial region of the accelerating system are obtained. The effect of accumulation of ions on the ring formation is considered. The problems concerning the electron ring creation in a static magnetic field necessary for the collective accelerator are discussed. (auth)

28707 EDDY CURRENTS, LANDAU-DAMPING COEFFICIENTS, AND THEIR IMPLICATIONS IN ELECTRON-RING COMPRESSOR DESIGN. Avery, Robert T.; Laslett, L. Jackson (Univ. of California, Berkeley). pp 465-7 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The strong influence of eddy currents on Landau-damping coefficients, as was observed and corrected in the LRL Compressor 4, is discussed. The improvement of these damping coefficients as a result of a redesign of Compressor 5 coils is reported. (auth)

28708 TRANSVERSE ERA. Brautti, G. (INFN, Bari, Italy); Clauser, T.; Boscolo, I.; Leo, M.; Luches, A. pp 486 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A report is given on theoretical and experimental work on a new type of collective heavy ion accelerator. Ion acceleration is produced by an electron ring which drifts perpendicularly to the external magnetic field. (auth)

28709 EXPERIENCE GAINED FROM THE NEW U. S. LINEAR ACCELERATORS. Wheeler, G. W. (Brookhaven National Lab., Upton, N. Y.). pp 531-9 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Three new proton linear accelerators in the U.S. (the 200 MeV injector linacs at the Brookhaven National Laboratory and the National Accelerator Laboratory and the 800 MeV meson factory, LAMPF, at the Los Alamos Scientific Laboratory) are coming into operation. Several new features have been incorporated in these machines, the most important being the field stabilization by means of coupling mechanisms between cells. Initial performance of the machines agrees in general very well with the design calculations. Available data are presented but more measurements are needed for complete comparison with the theory. While results are encouraging, peak design performance has not yet been achieved. (auth)

28710 RECIRCULATION OF THE SLAC BEAM. Herrmannsfeldt, W. B.; Allen, M. A.; Helm, R. H.; (and others) (Stanford Univ., Calif.). pp 563-7 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The intent of this proposal is to boost the energy of the SLAC beam into the 40 GeV range by recycling the electrons through the accelerator for a second pass. In order to use the normal klystron repetition rate (360 pps), the beam must be stored for the entire interpulse period (2.8 ms). Storage would be achieved in a 6.9 km-long path extending over the entire length of the accelerator housing. The direction of the beam would be reversed in magnet loops located at the ends of the accelerator. Beam energy losses due to synchrotron radiation would be made up by a room temperature linac operating at the accelerator frequency (2856 MHz). At the end of the storage interval, corresponding to about 122 revolutions, the beam would be reinjected into the accelerator to be accelerated for a second time. The final energy would equal the sum of the energy during storage plus the energy gained on the second pass. The recirculator could also be used for high duty cycle (up to 7%) experiments at the recirculating energy by simply storing the beam and extracting about 1% of the electrons per revolution. (auth)

28711 ACCELERATION OF NITROGEN IONS TO 7 GEV IN THE PRINCETON PARTICLE ACCELERATOR. White, M. G.; Isaila, M. V.; Allen, H. L; Prelec, K. (Princeton Univ., N. J.). pp 568-73 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Nitrogen ions in charge state N^{5+} and N^{6+} have been accelerated in the Princeton Particle Accelerator (PPA) to 4 and 7 GeV respectively. An external N^{5+} beam of 3×10^5 particles/sec has been obtained while the N^{6+} beam was about 2×10^5 particles/sec. The measured total charge-changing cross section of N^{5+} was found to decrease from 5×10^{-17} cm^2/molecule at 0.6 MeV/amu to 3×10^{-18} cm^2/molecule at 40 MeV/amu. Calculation shows that an improvement in vacuum from 2.2×10^{-7} Torr to 1×10^{-7} would increase the N^{5+} beam by at least tenfold. Rough measurements of the N^{6+} total cross section indicate that it is smaller than the N^{5+} at the higher energies. Some initial experimental results on the properties of the 4 GeV beam are presented. (auth)

28712 HEAVY ION ACCELERATION AT THE BEVATRON. Grunder, H. A.; Hartsough, W. D.; Heckmann, H. H.; Lofgren, E. J. (Univ. of California, Berkeley). pp 574-7 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Deuteron, alpha and nitrogen beams have been accelerated in the Bevatron and extracted, at beam energies between 280 MeV/nucleon to 2.1 GeV/nucleon. Nitrogen ions have also been accelerated to 36 GeV total energy. Completion of the resonant extraction system and recent extension of digital control to the acceleration cycle made this program feasible. Changing from proton operation to deuterons or alphas requires retuning which is within capability of the computer control. Deuteron and alpha beam intensities are well within the range of the feedback-loops. A special technique was developed using alpha particles as a tracer for nitrogen ion acceleration. Several exploratory experiments in physics, biology and nuclear chemistry using these beams have been performed. (auth)

28713 POSSIBILITIES FOR CYCLOTRON ACCELERATION OF HIGH-ENERGY PARTICLES. Dzhelepov, V. P.; Dmitrievskii, V. P.; Zamolodchikov, B. I.; Kolga, V. V.; Polumordvinova, N. I. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 578-80 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Some theoretical investigations are given which point to the possibility of applying the cyclotron method of particle acceleration in the relativistic region of velocities, the dynamic similarity and mirror-symmetric structure of the leading magnetic field being conserved. (W.H.K.)

28714 STUDY OF RESONANT EXCITATION OF CHARGE DENSITY WAVES FOR COHERENT ACCELERATION OF IONS. Khiznyak, N. A.; Aseev, G. G.; Kuznetsova, G. G.; Repalov, N. S. (Physical Technical Inst., Kharkov). pp 583-6 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Coherent acceleration of ions by forces originating from space charge of a non-compensated electron bunch can be realized in electron beams with density modulation. But it is known that practical realization of high-level modulation of dense beams is accompanied by considerable difficulties. Heavy modulation of an electron beam moving in spatially periodic structures is found when resonant excitation of charge density waves takes place in the beam. It is suggested to use resonant excitation of large amplitude charge density waves for coherent ion acceleration. (auth)

28715 COLLECTIVE ACCELERATION OF IONS BY SCANNING AND ROTATION OF AN ELECTRON BEAM. Kolomenskii, A. A.; Logatchev, I. I. (Lebedev Inst. of Physics, Moscow). pp 587-91 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The two variants of the acceleration of ions captured by the potential well of a dense electron beam are considered including the scanning method and the centrifugal method. In the latter case the electron beam rotates in the plane or in the surface of a cone; the ions are being accelerated slipping along the beam and shifting onto a greater radius. The influence of the ions on the depth of the electron beam potential well during acceleration is considered. (auth)

28716 AUTOACCELERATION IN ELECTRON BEAMS. Kazanskii, L. N.; Kisletsov, A. V.; Lebedev, A. N. (Lebedev Inst. of Physics, Moscow). pp 592-6 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Possibilities of particle acceleration in proper fields of an intense electron beam are discussed. A self-consistent steady state is investigated where the necessary field configuration and the longitudinal stability of the bunched beam are provided by a passive retarding system. (auth)

28717 PARTICLE MOTION NEAR A SURFACE ON WHICH TOTAL INTERNAL REFLECTION OF ELECTROMAGNETIC WAVES TAKES PLACE. Kheifets, S. A. (Erevan Physical Inst.). pp 597-9 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The motion of a particle in vacuum in the field of an elliptically polarized electromagnetic wave undergoing total internal reflection is considered. Conditions for the stability of the motion are found. The motion of an equilibrium particle, as well as the change of the small deviations, is considered. Expressions for the frequencies of the small oscillations are obtained. The possibility of using the effect for particle acceleration by means of a laser beam is analyzed. (auth)

Auxiliaries and Components

Refer also to abstracts 28259 and 28823.

28718 (CONF-720401-4) MEASUREMENT SYSTEM FOR SUPERCONDUCTING RF RESONANT CAVITIES. Peebles, P. Z. Jr. (Tennessee Univ., Knoxville); Jones, C. M.; King, R.; Judish, J. (Oak Ridge National Lab., Tenn.). [1972]. 13p. Dep. NTIS.

From Region III conference on scanning the spectrum; Knoxville, Tenn. (10 Apr 1972).

Special considerations must be given to measurement techniques when making measurements on superconducting RF resonant cavities. A system using an oscillator loop is described that is especially designed to overcome most problems associated with narrow bandwidth (Q's of 10^8 or more), high field levels and instabilities. (auth)

28719 (ORNL-TM-3654) FAST FREQUENCY-TUNING OF SUPERCONDUCTING RESONANT RF CAVITIES FOR HEAVY ION LINEAR ACCELERATORS. Peebles, Peyton Z. Jr. (Oak Ridge National Lab., Tenn.). 15 Feb 1972. Contract W-7405-eng-26. 35p. Dep. NTIS.

Superconducting resonant radio frequency (RF) cavities which utilize helices for producing "slow" wave velocities are prime candidates for creating the large accelerating electric fields needed in linear heavy ion accelerators. Because such structures are subject to mechanical vibrations, these vibrations may cause fast shifts in the cavity resonant frequency. The result of such shifts is to cause undesirable phase modulation of the accelerating field. Results of a study of an all-electronic method of fast tuning of the cavity to compensate for the vibration are described. Two types of control are discussed. The first employs only two electrical entrance points (ports) to the cavity. It is mechanically simpler than the second type, which uses three ports, but suffers some undesirable features not present in the three-port method. (auth)

28720 (SC-RR-720058) PINHOLE DIAGNOSTICS FOR DIRECT MEASUREMENTS OF LOCALIZED ANGULAR DISTRIBUTIONS IN RELATIVISTIC HIGH CURRENT ELECTRON BEAMS. Kelly, J. G.; Bradley, L. P. (Sandia Labs., Albuquerque, N. Mex.). Jan 1972. 52p. Dep. NTIS.

The development of the pinhole diagnostic technique is described for the direct measurement of the electron angular distribution at a well defined position in a relativistic electron beam. Theoretical calculations are presented which have been used to justify the accuracy of the technique, to correct the data, and to set limits on the regions of validity of the measurements. Some results of tests on the Reba and the Nereus electron accelerators are presented. (auth)

28721 COMPUTER COMPATIBLE SERVO SYSTEM FOR CYCLOTRON RF. Sigg, P. (Michigan State Univ., East Lansing). Nucl. Instrum. Methods; 99: No. 2, 397-403(1972).

A new servo control system, which allows computer as well as manual setup of the rf system of the MSU cyclotron, was built and tested. It features automatic switching to phase detectors when the desired positions are reached in order to fine-tune the system if the rf drive goes on. (7 figures) (auth)

28722 STABILIZATION SYSTEM FOR RESONANT CAVITY EXCITATION. Kerns, Quentin A. (to United States Atomic Energy Commission). U. S. Patent 3,638,127. 25 Jan 1972. Filed 29 Jan 1970.

A stabilization system for resonant cavity excitation of a particle accelerator or particle storage ring includes a pair of cavity current control tubes coupled in parallel. One tube is coupled to a beam pickup in the accelerator to provide a cavity current which is a function of the beam intensity. The current through the other tube is controlled by a comparison between the voltage across the accelerating gap and a desired voltage. The currents through each of the pair of tubes are combined to provide excitation for the cavity. Each of the pair of tubes may consist of a number of tubes in parallel. The cavity is constructed so that energy at undesired frequencies is absorbed. (auth)

28723 BRAIDED SUPERCONDUCTOR. Sampson, William B.; Britton, Richard B. (to United States Atomic Energy Commission). U. S. Patent 3,638,154. 25 Jan 1972. Filed 26 Mar 1970.

A beam transport magnet having braided superconductor windings for pulsed operation for use in high-energy accelerators and beam transport systems is described. (W.H.K.)

28724 CONTINUOUS MEASUREMENT AND CONTROL OF MAXIMUM BREMSSTRAHLUNG ENERGY OF AN ELECTRON ACCELERATOR. Klapper, F. (Friedrich-Schiller-Univ., Jena, Ger.). Kernenergie; 14: No. 9, 289-305(Sep 1971). (In German).

A new possibility is proposed for measuring the maximum energy of high-energy bremsstrahlung. Using two ionization chambers having heavily opposite dependence on energy and a filter arranged between them, the magnitude of the ionization current ratio of the two chambers is a measure of the maximum bremsstrahlung energy. With a measuring time of 1 s, an energy resolution of 5×10^{-5} is obtained within a range of maximum bremsstrahlung energy from 10 to 40 MeV. As a consequence, this method surpasses the methods used so far for measuring the maximum bremsstrahlung energy by about 10^3 times in measuring time and by one order of magnitude in energy resolution. The arrangement allows control of the energy of an electron accelerator in the above energy range in the form of a closed control loop by means of the bremsstrahlung emitted directly. (auth)

28725 STUDIES AND CONSTRUCTION OF SUPERCONDUCTING MAGNETS APPLIED TO SYNCHROTRONS OF MORE THAN 1000 GeV. Bronca, G.; Levy-Mandel, R.; Neyret, G.; Parain, J.; Perot, J. (CEN, Saclay, France). pp 177-82 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The main characteristics of superconducting magnets are investigated in connection with their use in a synchrotron of more than 1000 GeV. (auth)

28726 SUPERCONDUCTING SYNCHROTRON MAGNET PERFORMANCE IN A CLOSED CIRCUIT CRYOGENIC SYSTEM. Brechna, H.; Green, M. A.; Heinz, W. (Kernforschungszentrum, Karlsruhe, Ger.). pp 183-9 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Technical criteria to design, build, and operate synchrotron magnets are discussed. Some of the work performed at IEKP (Karlsruhe) is reported. (auth)

28727 SUPERCONDUCTING SYNCHROTRON DEVELOPMENT AT BNL. van Steenbergen, A. (Brookhaven National Lab., Upton, N. Y.). pp 196-205 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A few aspects of a design study of a superconducting synchrotron of nominally 100 GeV proton energy are presented, related to basic parameters, magnet-dewar system, resonant extraction with "imperfect" superconducting dipoles, and the possibility of partial corrections for magnet component errors in a synchrotron lattice. In a separate Appendix a progress report on the superconducting magnet work being carried out at BNL is given, dealing with the state of development of conductors and magnet circuit design, and further summarizing the performance data of test solenoids and model synchrotron magnets. In conclusion, plans for the design of superconducting storage rings and specific superconducting component development are indicated. (auth)

28728 MULTI-STAGE ENERGY TRANSFER SCHEMES. Smith, P. F. (Rutherford High Energy Lab., Chilton, Eng.). pp 213-17 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

An extension of the superconducting energy transfer principle is described with particular reference to its possible applications to synchrotron power supplies. By successively switching in a number of superconducting transformers a considerable reduction in the size of the rotating transfer coils can be achieved for a given final energy. Advantages and disadvantages are summarized, and possible switching methods are discussed. In addition an alternative hybrid scheme is noted, in which the superconducting transformers are driven by a conventional power supply. (auth)

28729 CRYOGENIC PROPERTIES OF METALLIC AND NONMETALLIC MATERIALS UTILIZED IN LOW TEMPERATURE AND SUPERCONDUCTING MAGNETS. Brechna, H.; Hartwig, G.; Schauer, W. (Kernforschungszentrum, Karlsruhe, Ger.). pp 218-23 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The mechanical, thermal, and magnetic properties of metals and the mechanical and thermal properties of plastics at cryogenic temperatures are treated quantitatively for the design of low-temperature normal and superconducting magnets. (W.H.K.)

28730 SOME ASPECTS OF THE SUPERCONDUCTING MAGNETS DESIGN FOR HIGH ENERGY PROTON SYNCHROTRONS. Alekseev, V. P.; Meshcherov, R. A.; Mironov, E. S.; Vasil'ev, A. A. (Radiotechnical Inst., Moscow). pp 228-30 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The RTI superconducting program related to proton synchrotrons and the present situation of this work are described, and some problems of pulsed superconducting magnet design are discussed. (auth)

28731 SYNTHESIS OF AIR-CORE MAGNETIC SYSTEMS FOR SUPERCONDUCTING ACCELERATORS. Voronin, V. S. (Lebedev Inst. of Physics, Moscow). pp 231-3 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A computer method for finding configurations of surface currents for creating a given magnetic field in a certain working region is described. The method has been used to find winding configurations for superconducting magnetic systems of various accelerators. (auth)

28732 MEASUREMENTS AT SLAC ON SUPERCONDUCTING NIOBIUM CAVITIES AND STRUCTURES. Wilson, P. B.; Allen, M. A.; Deruyter, H.; (and others) (Stanford Univ., Calif.). pp 237-41 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Tests are continuing at SLAC on superconducting niobium cavities and structures at S- and X-band frequencies. Peak electric and magnetic fields on the order of 20 MV/m and 400 G have been obtained in a TM mode cavity at 2.85 GHz with unloaded Q's at high fields on the order of 10^{10}. These fields and Q's are adequate for superconducting RF systems for high energy storage rings and recirculating linear accelerators. (auth)

28733 RESEARCH ON SUPERCONDUCTING NIOBIUM CAVITIES AT BROOKHAVEN. Halama, H. J. (Brookhaven National Lab., Upton, N. Y.). pp 242-7 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Recent experiments on superconducting niobium cavities were aimed primarily at achieving high Q's at high rf field levels and at producing more stable surfaces. Best results were obtained with electron-beam-welded cavities machined from large grain billets and outgassed above 1800°C in the furnace at the High Energy Physics Laboratory at Stanford. The highest surface magnetic and electric fields were $\hat{B} \approx 550$ G and $\hat{E} \approx 21.5$ MV/m measured in the TM_{010} and TM_{110} modes, respectively. Improvement factors in all modes between 2.3 and 4.1 GHz were above 10^5. Anodized cavities exhibit initially higher Q's but they deteriorate when kept at room temperature even in a good vacuum. Anodic films of Nb_2O_5 are therefore not suitable as protective surfaces at room temperature. In order to gain some information on the influence of irradiation on Q's and B's, the cavities were placed in the direct beam of Brookhaven's 200-MeV proton linac. Unoxidized cavities show a decrease of about 40% in residual Q's when irradiated with ~10^{18} protons/cm^2. Much more severe deterioration in both Q's and peak fields occurs in anodized cavities. These measurements represent the only radiation damage data on superconducting microwave devices. (auth)

28734 MEASUREMENTS ON SUPERCONDUCTING HELICES FOR THE FIRST SECTION OF THE SUPERCONDUCTING PROTON ACCELERATOR AT KARLSRUHE. Citron, A. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.); Fricke, J. L.; Jones, C. M.; (and others). pp 278-81 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Measurements on a superconducting helically loaded resonator are described. Peak electric fields up to 30 MV/m and magnetic fields up to 1000 G at high field Q's in the order of 10^8 were obtained in CW operation. Peak fields in the fundamental mode were limited by electron field emission and in the first harmonic mode by thermal breakdown. No drastic changes in Q and peak fields were observed due to cycling the resonator between He and room temperatures. (auth)

28735 ELECTROMAGNETIC FIELD DISTRIBUTION DUE TO A BEAM-EXCITED RE-ENTRANT CYLINDRICAL CAVITY MOUNTED COAXIALLY WITH A CYLINDRICAL VACUUM CHAMBER. Trickett, J. K. (CERN, Geneva). pp 345-7 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

An efficient method of solving the complex boundary value problem is described using Green's functions and an integral equation approach. From the knowledge of the field inside the beam, the coupling impedance can be simply calculated. A low frequency equivalent circuit is derived theoretically. (auth)

28736 MEASUREMENTS OF ENERGY SPECTRUM AND INSTABILITY OF THE SYNCHRONOUS BEAM ENERGY AT THE OUTPUT OF THE ION LINAC BY MEANS OF TRANSPARENT PICK-UPS DURING OPERATION. Beznogikh, Yu. D.; Dudnikov, V. G.; Voevodin, M. A.; Zinov'ev, L. P. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 423-5 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A method of measuring the energetic spectrum of the beam of charged particles at the ion linac output is considered. This method is based on a signal of the first harmonic of the Fourier expansion of a periodic sequence of bunches of charged particles produced at the ion linac output by means of a transparent pickup and an amplifying system. The method makes possible to obtain some information on an instantaneous value of the energetic spectrum for all the time of the injection. The use of two inductive pick-ups, located along the drift space of the injection system at some distance one from another, allows (after comparison of signal phases) to obtain some information on the instability of the injector synchronous energy during both one injection pulse and several pulses. (auth)

28737 INSTRUMENTATION AND BEAM DIAGNOSTICS IN THE ISR. Barlow, A.; Borer, J.; Hansen, S.; (and others) (CERN, Geneva). pp 426-30 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Topics include measurement of circulating beam current and luminosity; electrostatic pick-ups and related instrumentation (beam position monitoring system, special pick-ups and rf related signal observation, Q-measurements, band-pass filter signals, and dynamic frequency measurements); profile measuring devices for the circulating beam (beam scraping targets, ionization beam scanner, and beam scanning probes); and beam transfer and injection instrumentation (luminescent screens, SEM beam profile monitor, beam position electrodes, and beam current monitors). (W.H.K.)

28738 ON-LINE CONTROL OF THE CERN PROTON SYNCHROTRON CLOSED ORBIT AT INJECTION. van der Beken, H.; Burnod, L.; Daneels, A. (CERN, Geneva). pp 445-7 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The computerized acquisition and control system installed on the CERN proton synchrotron (CPS) has been used to implement an optimization loop acting on the beam closed orbit. A global method acting on the whole trajectory and a local one on about half a betatronic wavelength are described. (auth)

28739 AUTOMATIC DIGITAL MEASUREMENT OF BETATRON FREQUENCIES. Hansen, S. (CERN, Geneva). pp 448-9 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

An automatic system for measurements of the betatron frequency in the ISR is described. The system includes pulsed beam deflectors, electrostatic pick-up electrodes, band pass filters, zero-crossing detectors, and a digital device for calculating the non-integral part of the Q-value. (auth)

28740 COMPUTERIZED TREATMENT OF IONIZATION BEAM SCANNER (IBS) SIGNALS. Bovet, C.; Johnson, C. D.; Pedersen, K. O. H. (CERN, Geneva). pp 450-1 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Data acquisition and treatment of IBS profiles are used to improve precision of beam size measurements by applying corrections for instrumental broadening and for errors due to the beam space-charge potential. (auth)

28741 SOME REMARKS ON FUTURE ERA COMPRESSORS. Steinbock, L. (Institut fuer Experimentelle Kernphysik, Karlsruhe, Ger.). pp 478-80 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The present ERA compressors which produce relativistic electron rings consist of a set of Helmholtz coil pairs. For future accelerators a high repetition rate is desirable, which can be obtained with a single coil connected with a capacitor and operated with the resonance frequency of the capacitor-inductance loop. In order to fulfill the requirements for the proper focussing of the ring and to minimize the stored energy of the system it is necessary that the coil has a special geometry (flat cylinder) and winding distribution which is similar to that of a watch spring. A comparison between a conventional compressor and a spring coil compressor shows that this new concept needs an energy per ring which is about one order of magnitude smaller than that of a conventional one. (auth)

28742 COMPUTER-BASED ACCELERATOR CONTROL SYSTEM. Butler, Harold S. (Los Alamos Scientific Lab., N. Mex.). Advan. Instrum.; 25: Pt. 1, 534.1-7(1970).

From twenty-fifth annual conference of the Instrument Society of America; Philadelphia, Pa. (26 Oct 1970).

The prototype computer control system to be used on the Los Alamos Meson Physics Facility (LAMPF) is described. The operator's console was designed around a powerful graphics display scope incorporating a light pen. The prototype control system, operator's console, graphic control panels, multipanel displays, panels for optimization, programmable machinery, and application to LAMPF are discussed. (W.H.K.)

28743 OSNOVY ZASHCHITY USKORITELEI. (Fundamentals of Shielding for Accelerators). Zaitsev, L. N.; Komochkov, M. M.; Sychev, B. S. Moscow; Atomizdat (1971). 400p.

The experience, engineering design, utilization, and testing of accelerator shielding are discussed. Elementary particle-substance interactions, sources of radiation, and radiation from different types of accelerators are considered. Procedures for the selection of materials, components, and installations for shielding construction are recommended. (338 references.) (tr-auth)

28744 FREQUENCY-STABILITY IMPROVEMENT IN A KLYSTRON STABILISED BY A SUPERCONDUCTING CAVITY. Benard, J.; Jimenez, J. J.; Sudraud, P.; Viet, N. G. (Paris Univ., Orsay, France). Electron. Lett.; 8: No. 5, 117-18 (9 Mar 1972).

Measurements of the short-term and long-term stability of an X band klystron, stabilized by a high-Q-factor superconducting cavity, show that the signal has a stability of 3 parts in 10^{12} for a period of measurement of 10 s and a frequency shift of 1.7 Hz during 30 min. These performances were obtained by improving the operating parameters of the oscillator. (auth) (UK)

28745 95 MVA SURGE-POWER MOTOR-GENERATOR SET FOR THE MAIN RING MAGNETS OF THE 28-GeV CERN PROTON SYNCHROTRON AT GENEVA. Dressel, O. (Siemens AG, Berlin); Gross, S.; Mueller, H. Siemens Rev.; 38: No. 12, 542-7 (Dec 1971).

A detailed description of the electrical and mechanical design of the synchronous generator used in the motor-generator set is given. The main points discussed include the development of the required moment of inertia without employing an additional flywheel, the structural measures taken to handle the constant reversal of the torque in the shafting, and the oil supply system with its particularly high safety factor. (auth)

Ion Sources, Injection, and Extraction

28746 (LA-DC-72-296) PROGRESS REPORT ON THE LASL POLARIZED ION SOURCE. McKibben, J. L. (Los Alamos Sci-

entific Lab., N. Mex.). [1971]. 11p. (CONF-720314-1). Dep. NTIS.

From Symposium of North Eastern Accelerator personnel; Tallahassee, Fl. (23 Mar 1972).

The LASL polarized ion source which has been delivering ion beams up to 200 nA through the FN tandem for over two years is described. The stripper foil problem, the ion beam intensity problem, the use of a polarized source for production of polarized neutrons, and absolute polarization measurements are discussed also. (W.H.K.)

28747 DIRECT EXTRACTION OF NEGATIVE HEAVY IONS FROM A DUOPLASMATRON SOURCE. Cesati, A.; Cristofori, F. (CISE, Milan. Univ., Milan). Energ. Nucl. (Milan); 19: No. 1, 36-41(Jan 1972).

Intensity measurements are reported of negative heavy ion beams extracted from an Ortec Mod. 358 duoplasmatron source where different gas mixtures were used instead of pure hydrogen. Particular attention is given to negative ions with $A \simeq 20-30$. Intensities of analyzed beams are high for H^- (25 μA), O^- (8.5 μA), OH^- (8 μA), CN^- (9 μA), Cl^- (1.6 μA) and appreciable for C^- (200 nA), F^- (90 nA), and NH^- (90 nA). (auth)

28748 INCREASE OF INJECTION ENERGY OF THE 70 GeV PROTON SYNCHROTRON WITH THE GOAL TO INCREASE THE INTENSITY. Balbekov, V. I.; Vodopyanov, F. A.; Glukhikh, V. A.; (and others) (Inst. for High-Energy Physics, Serpukhov, USSR. Research Inst. of Electro-Physical Equipment, Moscow. Radiotechnical Inst., Moscow). pp 21-4 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The main parameters of a new injection system for increasing the beam intensity of the IHEP synchrotron up to $\sim 10^{13}$ protons/sec by increasing the intensity per pulse up to $\sim 5 \times 10^{12}$ protons/cycle are presented and discussed. A synchrotron with an average radius of about 16 m, operating at a repetition cycle of 25 Hz and filling the chamber of the main accelerator during 1.2 sec, i.e., per 30 cycles (each time one separatrix is filled), was chosen as the new injector. (W.H.K.)

28749 BEAM EXTRACTION FROM SYNCHROTRONS. Barton, Mark Q. (Brookhaven National Lab., Upton, N. Y.). pp 85-8 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Nearly all synchrotrons have some means of extracting the circulating beam. A description of the various techniques and technological requirements for these beams is given along with the performance expected and achieved. (auth)

28750 NEW INJECTION AND EJECTION PROCESSES AT SATURNE. Faure, J. (CEN, Saclay, France). pp 91-3 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Topics include injection at variable energy, ramping cavity and debuncher, capture and acceleration performances, instabilities, and the new resonant extraction system. (W.H.K.)

28751 ADIABATIC CAPTURE IN THE CERN PS. Boutheon, M.; Gareyte, J. (CERN, Geneva). pp 94-7 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

In order to improve accelerated intensity, the main magnet cycling has been modified in the initial phase of acceleration to allow a quasi-adiabatic RF capture. With a low injected current (20 mA), a capture efficiency of 80% was recorded which is very near to the computed figure. With an operational injected beam of 160 mA, difficulties appeared in the transverse planes due to the reduced $\dot{B}$. While the work is still in progress, an increase of 15% in the accelerated intensity has already been obtained. (auth)

28752 BEAM STACKING IN THE RADIAL BETATRON PHASE SPACE. Khoe, T. K.; Lari, R. J. (Argonne National Lab., Ill.). pp 98-101 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

An injector system for accumulating many injector pulses in the radial phase space is discussed. The method requires the use of bumper magnets which produce a dipole, a quadrupole, and an octupole field. The results of analytical and computer studies of the requirements on the bumper fields for injection of many pulses without phase space dilution are presented. (W.H.K.)

28753 MACROPARTICLE COMPUTER SIMULATION OF MULTITURN INJECTION INTO THE CERN PS BOOSTER. Bovet, C.; Lamotte, D.; Le Bail, R. (European Organization for Nuclear Research, Geneva). pp 102-4 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Multiturn injection will be necessary for filling the CERN Booster (PSB) when 10^{13} protons are to be accelerated since the injected current must then reach three times the Linac intensity. Though many aspects of this injection process have already been described by different authors, a Monte Carlo simulation with macroparticles is described to help clarify the dependence of the capture efficiency upon various parameters and to include space-charge effects. (auth)

28754 EFFECT OF NONLINEAR COUPLING ON RESONANT VERTICAL BEAM EXTRACTION. Courant, E. D. (Brookhaven National Lab., Upton, N. Y. State Univ. of New York, Stony Brook); Month, M. pp 106-9 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Nonlinearity of the magnets in a synchrotron limits the amplitude that can be reached in third-integral resonant beam extraction. This limit is calculated for the case of extraction out of the median plane when the principal magnet nonlinearity is symmetric in the median plane. The method used is the construction of the appropriate canonical invariants in four-dimensional phase space, using a version of the formalism of Moser, Hagedorn and Schoch. (auth)

28755 MULTIPLE TARGET EXTRACTION SHARING SCHEME AT THE CPS. Kubischta, W. (CERN, Geneva). pp 110-12 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The future CPS slow extraction system will be capable of sharing the beam between internal targets and either of two slow extraction channels. Simultaneous slow extraction sharing is possible when another pair of septa is added. A description of the system and results of tests with an experimental set-up are given. (auth)

28756 DEVELOPMENT OF AN ELECTROSTATIC SEPTUM FOR THE SLOW EJECTION OF THE CPS. Bleeker, J.; Germain, C.; Thivent, M.; Tinguely, R. (CERN, Geneva). pp 113-15 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN (1971). /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Since the beginning of 1970, an electrostatic septum has been used in the Machine Development studies devoted to a new slow ejection scheme of the CPS. Some problems related to various interactions of the beam with the septum are discussed. (auth)

28757 FAST EJECTION EQUIPMENT FOR THE SERPUKHOV 70 GeV PROTON SYNCHROTRON. Bossart, R.; Breugel, H. v.; Herin, S.; (and others) (CERN, Geneva). pp 116-19 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A summary description of the equipment is given together with the performance up to the date of the conference. (auth)

28758 INJECTION AND BEAM TRANSFER SCHEME OF THE JAPANESE PROTON SYNCHROTRON PROJECT. Kamei,

T.; Kihara, M.; Kondo, M.; (and others) (National Lab. for High Energy Physics, Oho-machi, Japan). pp 120-2 of Proceedings of the 8th InternationalConference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The machine which will be installed at the National Laboratory for High Energy Physics in Japan is an 8-GeV slow-cycling separated-function type proton synchrotron. For financial reason and manpower problems, the machine will be operated at about 8-GeV and at a moderate intensity at the first stage. The energy, however, can be raised up to 12-GeV with an additional fund for power stations and the intensity to 10^{13} p/s by successive improvements. The injection scheme for this machine has been examined in various points, and a combination of a 500-MeV fast-cycling booster and a 20-MeV linac was chosen. Some physical and technical problems concerning such a cascade injection scheme of relatively low energy machines are discussed. In particular, emittance-acceptance matching between the booster and the main ring and between the linac and the booster should be carefully studied together with the space-charge problems. The beam-transfer system from the booster to the main ring is also an important problem since a very fast timing control is needed for the synchrotron's phase matchings. (auth)

28759 DEVELOPMENT OF HIGH CURRENT ELECTRON SOURCES FOR AN ELECTRON RING ACCELERATOR. Andelfinger, C.; Buchelt, E.; Dommaschk, W.; (and others) (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). pp 471-4 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Two ways to improve the Febetron 705 gun for ERA purposes are described including an open field emission tube with a graded acceleration system and a tube with a laser irradiated cathode. Compared with the normal Febetron tube, the ratio of useful to total current was improved by a factor of 10, the instantaneous energy spread was reduced from 5% to 2.4% and 1.1% respectively (FWHM). Currents in an acceptance of 0.175 radcm are about 300 to 400 A. (auth)

28760 CYLINDRICAL BEAM STUDIES FOR THE MARYLAND ERA. Rhee, M. J.; Zorn, G. T. (Univ. of Maryland, College Park). pp 481-5 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A hollow cylindrical beam of 1.4 MeV electrons 5 cm in diameter produced by a pulsed field-emission diode has been studied. The number of particles in r-r' phase space within an emittance of 0.09 cm rad and within an energy interval at the maximum of 0.1% (corresponding time interval ~0.5 ns) was estimated to be 9×10^{12}. Beam dynamic studies are reported on the variation of the major radius of the beam with changing field along the axis and on the beam width as a function of the axial magnetic field near the anode. (auth)

28761 LINEAR PROTON ACCELERATORS. Murin, B. P. (Radiotechnical Inst., Moscow). pp 540-7 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The USSR, like many other countries, is carrying out extensive work on linear proton accelerators. Experiments are carried out and modifications are introduced at the linacs I-100 (the injector of the 76 GeV proton synchrotron at Serpukhov) and I-2 (the injector of the 7 GeV proton synchrotron at ITEP in Moscow) which are now in full operation. Theoretical and experimental studies are being conducted in connection with the projects of an 800- to 1000 MeV linear accelerator (injector for the cybernetic accelerator) and a 600 to 1000 MeV accelerator (meson factory), both under development at the Radiotechnical Institute. Works are carried out on the design of a 37 MeV linear accelerator to be used as an injector for the Serpukhov proton synchrotron booster. Particular attention is paid to investigations aimed at increasing the beam intensity and also at creating systems which can give better beam parameters at a reduced cost. Computer simulation is widely used to facilitate the investigations. A short review covering only the main branches and results of these works is presented. (auth)

Ion Optics and Field Calculations

28762 (IPP-9/1) STIGMATIC FOCUSING HOMOGENEOUS MAGNETIC SECTOR FIELDS. Eckstein, W.; Verbeek, H. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Jan 1972. 29p. (In German). Dep. NTIS (U. S. Sales Only).

For homogeneous magnetic sector fields with deflection angles of 30°, 40°, 45°, 50°, 60°, 70°, 80°, 90°, 100° and 110° with the condition of stigmatic focusing the possible combinations of the entrance and exit angles and the focusing lengths were calculated and are plotted in the area of physical interest. In a separate bound appendix the magnifications, the dispersion and the resolving power are plotted. (auth)

28763 (JINR-P9-6214) FREQUENCY SHIFT OF VERTICAL OSCILLATIONS INDUCED BY THE BEAM SPACE CHARGE. Glazov, A. A.; Dzhelepov, V. P.; Dmitrievskii, V. P.; Zamolodchikov, B. I.; Kol'ga, V. V.; Novikov, D. L.; Onishchenko, L. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

Experiments on the frequency shift of incoherent vertical oscillations induced by the forces of the beam space charge in an electron model of an isochronous cyclotron are described. The experimental results are in satisfactory agreement with the existing theory of this shift mechanism. (auth)

28764 (LBL-570) TRANSVERSE COHERENT INSTABILITIES IN MULTI-BUNCH BEAMS: A REMARK CONCERNING THE CRITERION FOR THE ABSENCE OF COHERENT BUNCH MODES. Moehl, Dieter (California Univ., Berkeley. Lawrence Berkeley Lab.). 17 Dec 1971. Contract W-7405-eng-48. 15p. Dep. NTIS.

The derivation of the decoupling criterion for transverse instabilities in bunched beams (E. D. Courant and A. M. Sessler, Rev. Sci. Instrum., Vol. 36 (1965) p. 426) is re-examined. The two limiting cases in which the within-bunch frequence spread is small or large compared to the inter-bunch spread are examined. (W.H.K.)

28765 COUPLING OF RADIAL AND VERTICAL OSCILLATIONS OF PARTICLES IN CYCLIC ACCELERATORS. Starzhinskii, V. M. Prikl. Mat. Mekh.; 35: No. 6, 1096-1100(Nov-Dec 1971). (In Russian).

Betatron particle oscillations in cyclic accelerators with weak focusing is examined. Equations of particle motion are written in Lyapunov's system, and with the aid of the small-parameter method, the vertical-radial oscillations of particles are determined. The transition from purely radial to vertical-radial oscillations is determined. (K.S.W.)

28766 TRANSVERSE BEAM INSTABILITIES AT THE BEVATRON. Grunder, H. A.; Lambertson, G. R. (Univ. of California, Berkeley). pp 308-10 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A coherent vertical oscillation occurs on the unbunched, coasting beam. At 5 GeV the threshold for observable vertical growth is about 1×10^{11} protons/pulse. The instability is suppressed by rf bunching. Oscillation frequencies observed are at $(n-\nu)$ times the circulation frequency with n having integral values of 3 through 10. Experimental data are presented. Analysis of the behavior as a coupled motion between the protons and neutralizing electrons is given. (auth)

28767 EXPERIMENTAL INVESTIGATION OF NONLINEAR RESONANCES AT THE IHEP 70 GeV ACCELERATOR. Gridasov, V. I.; Myznikov, K. P.; Fedotov, Yu. S.; Chepegin, V. N. (Inst. for High Energy Physics, Serpukhov, USSR). pp 311-13 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Non-linear resonances at the maximum energy of the IHEP accelerator were studied. The radial and vertical beam dimensions with and without magnetic field corrections and changes of the horizontal and vertical dimensions of the beam as a function of the detuning at crossing different resonances were measured and are presented graphically. (W.H.K.)

28768 USING OF LONGITUDINAL ACCELERATING FIELD FOR FREQUENCY MEASUREMENTS AND DAMPING OF RADIAL BETATRON OSCILLATIONS. Ivanov, Yu. S.; Kuzmin, A. A.; Senatorov, G. F.; Roginskii, L. A. (Radiotechnical Inst., Mos-

cow). pp 314-16 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A theory is briefly outlined of a feedback system in which a longitudinal accelerating field is used to affect the radial betatron motion. Experimental results obtained at the Serpukhov accelerator are also given. The system can be used both for exitation of the betatron oscillations to facilitate their frequency measurements and for damping of the self-exited oscillations (in case of resistive instability or nonzero initial conditions at injection). (auth)

28769 DAMPING OF THE LONGITUDINAL INSTABILITY IN THE CERN PS. Boussard, D.; Gareyte, J. (CERN, Geneva). pp 317-20 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

After a summary of the theory of the coherent longitudinal instability observed in the CPS, three different compensation techniques are presented: spread in the synchrotron frequencies of individual bunches, Landau damping by RF non linearities, and active feedback. Experimental results are described. (auth)

28770 THEORETICAL AND EXPERIMENTAL STUDY OF THE LONGITUDINAL SPACE-CHARGE EFFECTS IN PROTON LINACS. Nishikawa, T.; Okumura, S. (National Lab. for High Energy Physics, Oho-machi, Japan). pp 321-2 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The space-charge effect in proton linacs is experimentally studied by an electron model. Electrons are accelerated in the first 24 cells of the model cavity which has half-size dimensions of the designed proton linac. The output energy is 1.6-keV which corresponds to 2.8-MeV for protons. The output currents as a function of input currents are measured without changing the other accelerating conditions. A maximum current of 160 μA which is equivalent to a proton current of 300 mA in the space-charge effect is obtained. The output currents show a saturation around this value. These results are explained in terms of the longitudinal space-charge effect. The theoretical study of this effect shows that the space-charge limited currents will be determined at the low energy end but the effect of acceleration will considerably increase the currents. The experimental results are compared with the computations taking into account the acceleration effect. (auth)

28771 PASSING TRANSITION IN THE FUTURE CPS. Hardt, W.; Schoenauer, H.; Soerenssen, A. (CERN, Geneva). pp 323-6 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

When the future CPS operates with ~10^{13} p/p, the longitudinal space-charge parameter n is expected to be about 3, which corresponds to an $\eta_0(0)$ of about 4. In order to obtain favorable conditions for bunch matching, it is planned to combine the γ_t-jump method with the triple switch. The triple switch is used for matching, whereas the decreased γ_t generates a large bunch length at the matching point. In this way the solution is least sensitive to a spread of the space-charge parameter. Various arrangements for quadrupoles have been examined. all capable of achieving a change of γ_t about 0.6. (auth)

28772 BEAM-BUNCH LENGTH MATCHING AT TRANSITION CROSSING. Lee, W. W.; Teng, L. C. (National Accelerator Lab., Batavia, Ill.). pp 327-30 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A multiparticle computer program was written to study the γ_t-jump and ϕ_s-switch schemes for matching beam-bunch length in crossing the transition energy when the longitudinal space-charge force is significant. This computation takes into account nonlinearities in the forces and can, therefore, yield information about the bunch stability. The results show that all ϕ_s-switch schemes suffer from negative-mass instability shortly after transition. On the other hand, γ_t-jump schemes are stable and are effective for bunch-length matching. (auth)

28773 ENHANCEMENT OF THE ν-SPREAD IN A PROTON BEAM BY THE INSERTION OF AN ELECTRON BEAM. Ruggiero, A. G. (National Accelerator Lab., Batavia, Ill.). pp 331-3 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

For a circular beam with uniform density the transverse space charge forces are linear. The effect of the linear space charge is just a reduction $\Delta\nu$ of the transverse oscillation wave number. With nonuniform density distribution in addition to a reduction $\Delta\nu$ of the average ν-value, one expects the nonlinear space charge forces to produce a ν-spread $\delta\nu$. In many cases a ν-spread is desirable for supplying Landau damping to transverse instabilities. The ν-spread can be enhanced by the insertion of a thin beam of particles of the opposite charge in the middle of the original beam. Because of the dependence of the space charge force on γ^{-2}, a low-γ thin beam of opposite charge can be expected to produce a large ν-spread. The ν-spread in a nonuniform beam and its enhancement by the beam of opposite charge are computed. (auth)

28774 ANALOG METHOD FOR MEASURING THE LONGITUDINAL COUPLING IMPEDANCE OF A RELATIVISTIC PARTICLE BEAM WITH ITS ENVIRONMENT. Faltens, A.; Hartwig, E. C.; Moehl, D.; Sessler, A. M. (Univ. of California, Berkeley). pp 338-44 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The stability of a coasting beam against self-bunching (negative mass instability) may be expressed in terms of a beam coupling impedance. The impedance has contributions from self-fields, wall impedance, and curvature effects. Procedures for measuring the wall and curvature contributions to the coupling impedance by means of an analog in which the beam is replaced by a conductor propagating a TEM-like mode are described. Conditions are derived under which the measurements are valid, various measurement procedures are described, and results of the application of the method to the compressor of an electron ring accelerator are reported. (auth)

28775 EXPANSION METHOD FOR CALCULATING SPACE-CHARGE DYNAMICS. Soerenssen, A. (CERN, Geneva). pp 348-50 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A computer method for the calculation of non-linear space-charge problems where the particle distribution is roughly Gaussian is described. First, a coordinate transformation is performed so that the distribution function becomes almost stationary. Then the distribution function is expanded in Hermite polynomials and the expansion coefficients are used as dynamical variables. The method is being tried to explain the observed blow-up of bunches in the CERN PS while crossing transition. (W.H.K.)

28776 DETERMINATION OF AN EQUIPMENT DESIGN CRITERION FOR THE CERN PS BOOSTER FROM STABILITY CONSIDERATIONS OF COHERENT SYNCHROTRON MOTION. Gumowski, I. (CERN, Geneva). pp 360-2 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eight international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The synchrotron motion in the presence of self-fields and resonant structures in the accelerator ring is analyzed by means of a Hamiltonian and a non Hamiltonian model. An equipment design criterion for the CERN Proton Synchrotron booster is derived from this analysis. (auth)

28777 COHERENT RADIAL INSTABILITY DUE TO HORIZONTAL RESISTIVE WALLS. EVALUATION FOR SATURNE. Beck, R. A.; Gendreau, G.; Laclare, J.-L.; Leleux, G. (CEN, Saclay, France). pp 367-9 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The general expression for U and V defined in L. J. Laslett et. al., Rev. Sci. Inst., Vol. 36, 4, pp. 436-448 for coherent radial instabilities in a uniform rectangular pipe with horizontal resistive walls is given. The stability threshold is evaluated for Saturne ($N_{th} \sim 5\ 10^{14}$ p). (auth)

28778 BOUNDARIES OF STOCHASTICITY DOMAINS IN HAMILTONIAN SYSTEMS. Gumowski, I. (CERN, Geneva); Mira, C. pp 374-6 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Stochastic instability is related to non-linear oscillations for accelerator beam dynamics studies. Intersecting invariant curves of an area-preserving mapping are computed using an improved algorithm. The extent of the stochasticity domains is estimated from the positions of the homoclinic points. (auth)

28779 RESONANT INSTABILITY OF NONLINEAR OSCILLATIONS REPRESENTED BY FINITE DIFFERENCE EQUATIONS. Melekhin, V. N. (Inst. for Physical Problems, Moscow). pp 377-9 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The solution of nonlinear finite difference equations is found. The nonlinear frequency shift and the resonant instability produced by nonlinearity are calculated. The developed theory is applied to the calculations of the phase motion in a microtron. (auth)

28780 POTENTIAL BEAM BLOW-UP IN THE CERN PS BOOSTER DUE TO UNAVOIDABLE MAGNET IMPERFECTIONS AND CORRECTIVE MEASURES PROVIDED. Bovet, C.; Guignard, G.; Reich, K. H.; Schindl, K. (European Organization for Nuclear Research, Geneva). pp 380-3 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Magnet imperfections considered are (i) statistical fluctuations of the bending field B_0 and of the field gradient B', (ii) ring to ring variations, (iii) skew quadrupole fields, and (iv) higher order fields. As long as one stays away from the corresponding stop bands in the $Q_H - Q_V$ diagram, imperfections (i), (iii) and (iv) lead to distortions of the phase plane "ellipses" and to coupling between the two transverse planes rather than to actual beam blowup. Nevertheless, is is attempted to reduce the effects of all imperfections listed in order to be less restricted in the choice of Q_H, Q_V, to suffer a minimum dilution in six-dimensional phase space at the transfer into the CPS, and to facilitate PSB measurement and operation in general. The desirable upper limits of the multipole coefficients up to order four are discussed. In some cases they exceeded in practice and the corrective measures provided are described. (W.H.K.)

28781 INFLUENCE OF NONLINEAR COULOMB FORCES ON DISTORTION OF CONFIGURATION OF A BEAM PHASE VOLUME. Kuznetsov, V. S.; Trubnikov, G. I.; Kuznetsova, N. P.; Fidelskaya, R. P. (Scientific Research Inst. of Electrophysical Apparatus, Leningrad). pp 384-7 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The reasons are discussed which cause the distortions of the beam phase volume configuration. The results of numerical calculations for the phase density redistributions under the influence of the Coulomb forces for some accelerating and focusing systems are given, particularly, high current dc accelerators used as linear accelerator injectors. Regularities of the increase of the effective phase volume in accelerating and transporting a beam are considered. The dependence of distortions of the phase volume configuration on the initial phase density distribution is investigated. (auth)

28782 ELECTRON RING INSTABILITIES IN A WAVEGUIDE. Korenev, I. L.; Yudin, L. A. (Radiotechnical Inst., Moscow). pp 461-4 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The electron ring instabilities caused by radiative and resistive processes in a waveguide in the linear approximation are considered. The resistive processes play the essential role for frequencies below cut-off value and near waveguide resonances. (auth)

28783 SELF FIELD EFFECTS DURING THE MAGNETIC EXPANSION OF AN ION LOADED ELECTRON RING. Kappe, P. (Institut fuer Experimentelle Kernphysik, Karlsruhe, Ger.). pp 475-7 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

In the electron ring accelerator the inherent self fields of an electron ring are used to keep and accelerate ions. For dense electron rings self field phenomena are important beyond the property of merely dragging the ions. So far, self field effects mostly have been investigated for electron rings which are axially at rest. The space charge influence on the expansion kinematics in an axially decreasing field is calculated. (auth)

28784 RADIATION REACTION FORCE ON ELECTRON RING PASSING THROUGH ACCELERATOR. Berezhnoi, V. A.; Voskresenskii, G. V.; Kurdyumov, V. N.; Plis, A. I. (Radiotechnical Inst., Moscow). pp 487-90 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The radiation reaction force distribution along a traveling path of the electron ring uniformly moving through a single cavity with drift tubes is investigated by means of numerical methods. The total radiation losses of moving source per one structure period for a model of periodic structure with the channel are calculated using the factorization technique. (auth)

28785 SINGLE BUNCH RADIATION LOSS STUDIES AT SLAC. Koontz, R. F.; Loew, G. A.; Miller, R. H. (Stanford Univ., Calif.). pp 491-5 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The experiments described in this paper have been prompted by interest in the radiation loss of relativistic electron rings passing through periodic structures. In these experiments, single bunches of electrons with intensities up to 10^9 particles per bunch are accelerated through the SLAC three-kilometer accelerator and their energy spectrum is analyzed. Although only a limited number of measurements have been conducted to date, some broad conclusions can be drawn: (a) the radiation loss for a single bunch of 10^9 electrons traversing ~86,000 cavities of the accelerator is of the order of 38 MeV; (b) between 900 MeV and 19 GeV, the radiation loss seems to be independent of energy; and (c) the dependence of radiation loss on charge in the bunch appears to be linear. The instrumentation and equipment used to generate single bunches is described also. Additional experiments are being planned during 1971 and 1972 which should further define the results presented. (auth)

28786 RESONANT COUPLING OF TRANSVERSAL OSCILLATIONS DUE TO POLARIZATION OF ELECTRON-ION RINGS. Koshkarev, D.; Zenkevich, P. (Inst. for Theoretical and Experimental Physics, Moscow). pp 496-8 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The resonant coupling between the oscillations of the odd moments of one beam and the even moments of another one has been considered which appears only due to the accelerating field. The resonant condition is $nQ_e + (n \pm 1)Q_i = K$, where n and K are integers and Q_e and Q_i are betatron frequencies of electrons and ions. The analysis of the results obtained shows that the maximal polarization of the electron-ion rings is limited by these resonances. (auth)

28787 LIMITATIONS ON BEAM QUALITY AND INTENSITY. Hereward, H. G. (CERN, Geneva). pp 548-53 of Proceedings of the 8th International Conference on High-Energy Accelerators,

CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Transverse space charge is the limiting factor on beam quality in some simple situations, but a great variety of other effects are known, and are classified. Also, the longitudinal instabilities of bunched beams are discussed. (30 references) (auth)

28788 INTENSITY LIMITS AND BEAM QUALITY IN THE LINATRON (RECYCLED ELECTRON LINAC). Gonella, L. (Istituto Nazionale Fisica Nucleare, Turin. LIRF, Turin); Barbero, D.; Pasino, V.; Rebola, S.; Strigazzi, A. pp 557-62 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The intensity limit of a recycled linac, set by the phase dynamics, can be raised with a beam-load compensation to the efficiency level of straightforward linacs, allowing full exploitation of its narrow spectrum and high voltage yield. (auth)

28789 HIGH INTENSITY BUNCH SELF-FOCUSING IN PERIODIC WAVEGUIDE SYSTEMS. Valdner, O. A.; Masunov, E. S. (Moscow Inst. of Physical Engineering). pp 581-2 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Some problems of high-density particle bunch movement in a periodic waveguide structure are discussed. Such bunches can be used for a collective method of acceleration. Taking into consideration the peculiarities of reaction force in these waveguide systems, it is shown in the elementary examples that greater effective longitudinal and tangential focusing of bunches can be obtained if one makes use of periodic waveguide systems. (auth)

28790 POSSIBILITY OF SELF-FOCUSING OF PARTICLES IN A CYCLIC ACCELERATOR. Bashmakov, Yu. A.; Belovintsev, K. A.; Bessonov, E. G. (Lebedev Inst. of Physics, Moscow). pp 603-4 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The possibility of self-focusing of particles in cyclic accelerators is shown. The energy at which self-focusing effects occur is found for some special cases. (auth)

28791 FOCUSING PROPERTIES OF A HOMOGENEOUS MAGNETIC FIELD AND A PERPENDICULAR HYPERBOLOID ELECTRIC FIELD. Glikman, L. G. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 10, 1593-7(Apr 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 10, 2009-15(Oct 1971).

The focusing properties of a time-varying axially symmetric homogeneous magnetic and a perpendicular hyperboloid electric field with coaxial symmetry axes are investigated. Under certain conditions, charged particles with the same charge-to-mass ratio emitted from a given point at the initial time are focused at another point at certain times; there are no aberrations. In general, the time of a three-dimensional object in such a field is irregular since the magnification is different in different directions. For the special case in which the magnetic and electric fields are constant in time, particles with the same charge-to-mass ratio produce erect or inverted aberration-free images of a source of any shape with a magnification of 1 : 1 for certain conditions. Also, the focusing properties of the field resulting from the combined effects of a constant perpendicular two-dimensional electric field set up by a quadrupole lens (whose equipotential surfaces are hyperbolic cylinders) and a constant homogeneous magnetic field are considered. (auth)

28792 COMBINED CYLINDRICAL ELECTRON MIRRORS. I. Kel'man, V. M.; Fedulina, L. V.; Yakushev, E. M. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 10, 1598-1602(Apr 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 10, 2016-22(Oct 1971).

The paraxial properties of a combined cylindrical mirror consisting of electric and magnetic fields that form a two-dimensional system with a common median plane are considered. The second- and third-order vertical aberration constants are calculated. (auth)

28793 LONGITUDINAL PARTICLE DYNAMICS IN BUNCHERS FOR HIGH-CURRENT LINEAR ACCELERATORS. Podshivalov, V. N.; Sobenin, N. P. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 10, 1659-61(Apr 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 10, 2094-7(Oct 1971).

A technique is discussed for computing the longitudinal dynamics of electrons in bunchers of high-current linear electron accelerators with allowance for specific bunchers. (auth)

28794 ENERGY LOSS OF ELECTRON RINGS MOVING THROUGH A CAVITY RESONATOR. Voskresenkii, G. V.; Kurdyumov, V. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 10, 1666-71(Apr 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 10, 2103-10(Oct 1971).

The excitation of a cylindrical resonator and driving waveguides by an annular electron bunch moving uniformly along the axis of the cavity is considered. It is shown that this ring loses energy in exciting discrete eigenfrequencies of the structure and in radiation into the waveguides (continuous spectrum). For ultrarelativistic motion of the ring, the radiation into the waveguides increases linearly with ring energy. (auth)

28795 FIFTH-ORDER SPHERICAL ABERRATION OF A QUADRUPOLE–OCTUPOLE LENS. Lyubchik, Ya. G.; Ovsyannikova, L. P.; Fishkova, T. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 10, 1724-9(Apr 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 10, 2175-81(Oct 1971).

The fifth-order spherical aberration of a combined quadrupole–octupole lens with arbitrary electrode and pole shapes is calculated. The equations of motion of the charged particles are given to fifth order. The equations are solved by successive approximations. The spherical aberration coefficients of the width of the linear image in the median plane of the lens are written in quadratures. Expressions are obtained for these coefficients in the thin-lens approximation and the condition for the third- and fifth-order spherical aberrations to be compensated simultaneously is found. Two examples of quadrupole–octupole lenses with different shapes are considered. (auth)

28796 CORRECTION OF ABERRATIONS OF A WIDE-ANGLE LENS SYSTEM. Baranova, L. A.; Ovsyannikova, L. P. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 10, 1730-3(Apr 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 10, 2182-5(Oct 1971).

Expressions are obtained for the aberration coefficients of oblique beams in a system containing an arbitrary number of lenses. The possibility of correcting aberrations by using octupoles is considered. Expressions are presented for the aberration coefficients of a single octupole, and the condition for correcting the aberrations of a quadrupole lens by using such an octupole is also presented. (auth)

28797 SPACE-CHARGE NEUTRALIZATION IN LARGE CYCLICAL ACCELERATORS. Mingalev, B. S.; Shukeilo, I. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 10, 1784-5(Apr 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 10, 2247-8(Oct 1971).

The factors which inhibit neutralization of an intense proton beam by the slow electrons produced in ionization of the residual gas in a vacuum chamber are indicated. When the proton beam is bunched in azimuth, the electrons are lost to the chamber walls along the lines of force of the magnetic field. Quantitative data are presented for the Serpukhov accelerator. (auth)

Storage Rings

Refer also to abstracts 28787, 28797, and 29130.

28798 (BNL–16617) HIGH-FIELD BENDING MAGNETS FOR ISABELLE. Parzen, G.; Jellett, K. (Brookhaven National Lab., Upton, N. Y.). 29 Feb 1972. 16p. Dep. NTIS.

Circular bending magnets with a cosine current distribution, a 3 in. aperture, and going up to 40 kG are studied. A magnet is proposed that fulfills the suggested tolerances for ISABELLE. Topics discussed include approximating the cosine current distribution using a ribbon winding, choice of the iron shield parameters, dependence of the multipole terms on the field and the iron shield parameters, the sextupole correction windings, and tolerances for random errors in the coil locations. (auth)

28799 GENERATION AND STORING OF POSITRONS IN THE STORAGE RING OF THE PHYSICOTECHNICAL INSTITUTE OF THE UKRAINIAN ACADEMY OF SCIENCES. Adeishvili, D. I.; Grishaev, I. A.; Kozin, V. P.; Mocheshnikov, N. I.; Tolstoi, A. E. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 8, 1324-9(Aug 1971). (In Russian).

The conditions are considered for the generation, acceleration, and storing of a positron beam in the 100 MeV storage ring of the Physicotechnical Institute of the Ukrainian Academy of Sciences. The main characteristics of the positron beam are given. (auth)

28800 PROTON–ANTIPROTON COLLIDING BEAMS. pp 72–8 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The possibilities of producing proton–antiproton colliding beams are discussed. Special attention is paid to physical and technical aspects of electron cooling. Also, the current status of VAPP-NAP project is described. (auth)

28801 CERN INTERSECTING STORAGE RINGS. Johnsen, K. (CERN, Geneva). pp 79–84 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The present status of the CERN Intersecting Storage Rings is described together with details of the performance during the first few months of operation. Maximum currents of 6.9 A have been achieved to date and the present limitations appear to be due to gas desorption from ion bombardment of vacuum-chamber walls. At present, about 30 h/week (average) is devoted to colliding-beam physics under good background conditions and very low losses at currents up to about 4 A in each ring. (auth)

28802 RESONANT INJECTION FOR AN ELECTRON RING COMPATIBLE WITH A RESONANT EXTRACTION. Servranckx, R. (Univ. of Saskatchewan, Saskatoon). pp 123–4 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A short investigation on "inhalation" injection (or resonant injection) for an electron storage ring that was suggested at the 1971 Particle Accelerator Conference in Chicago is described. The characteristics of the electron pulse stretcher ring design that are relevant to the study are recalled. Computational data are presented that show that such a process is theoretically feasible. They are followed by considerations of the advantages and disadvantages and a conclusion of rejection of the idea for the EPS ring project. (auth)

28803 STATUS REPORT ON ACO. pp 127–31 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Development and beam studies on ACO are presented concerning experiments with a longitudinal solenoid field in the interaction region, new magnetic structures, and beam polarization. (auth)

28804 STATUS REPORT ON ELECTRON–POSITRON STORAGE RING VEPP-3. pp 138–9 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The development and operation of the VEPP-3 electron–positron storage ring are outlined. (W.H.K.)

28805 COLLIDING ELECTRON AND POSITRON BEAMS IN THE CEA BYPASS. Averill, R.; Hofmann, A.; Little, R.; (and others) (Harvard Univ., Cambridge, Mass. Massachusetts Inst. of Tech., Cambridge). pp 140–4 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The status and performance of the CEA colliding beam system are described. Single beams up to 50 mA peak and 12 mA average have been successfully switched into the low-beta bypass and stored at energies up to 2.5 GeV. Lifetimes at low currents were up to 5000 s. Stable operating conditions have been found for values of beta as low as 7 cm (horizontal) and 22 cm (vertical). Preliminary luminosity measurements at lower currents and energies of 2 and 2.5 GeV are described. (auth)

28806 SLAC STORAGE-RING PROJECT: SPEAR. Voss, J.; Scholl, R.; Sabersky, A.; (and others) (Stanford Linear Accelerator Center, Calif.). pp 145–9 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The SLAC positron–electron storage ring SPEAR is a single ring comprising two superperiods and having two interaction regions. It will operate initially at energies up to 2.5 GeV and at luminosities up to about 10^{32} cm^{-2} sec^{-1}. The main features of the design, including the magnet system, the vacuum system, the radiofrequency system, the injection system, and the computer-based instrumentation and control system, are described. Initial operation of SPEAR is scheduled for April 1972. Options for future improvement of the storage ring, which include raising the beam energy as high as 4.5 GeV and adding a second intersecting storage ring, are also discussed. (auth)

28807 ORSAY COMPENSATED COLLIDING BEAM RINGS (D. C. I.). Arzelier, G.; Belbeoch, R.; Bergher, M.; (and others) (Laboratoire de l'Accelerateur Lineaire, Orsay, France). pp 150–2 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The electron–positron double ring under construction at Orsay is based on the principle of space charge compensation using four beams. The project is presented, and the main features are discussed including beam characteristics, magnetic structure, radiofrequency system, injection, and vacuum. Planning and cost estimates show that the machine could be put in operation in 1974. (auth)

28808 HIGH ENERGY PROTON–ELECTRON–POSITRON COLLIDING BEAM SYSTEM. Pellegrini, C. (LNF, Frascati, Italy); Rees, J.; Richter, B.; (and others). pp 153–8 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A system of two intersecting storage rings of gross radius 260 m, one for protons and the other for electrons and positrons, is described. The maximum energy of the stored proton beam is 70 GeV, that of the electron and positron beams 15 GeV; so the center-of-mass energies are 65 GeV for e-p collisions and 30 GeV for $e^+ - e^-$ collisions. The performance of the system is determined by the RF power available for the electron and positron beams and by the incoherent beam–beam limit on transverse beam density. With an available RF power for the beams of 2.7 MW, the system yields design luminosities in the vicinity of 10^{32} cm^{-2} sec^{-1} in both modes of operation. Some important physics experiments and their yields are discussed. (auth)

28809 SOME DESIGN FEATURES OF AN ELECTRON STORAGE RING USED AS A PULSE STRETCHER. Westcott, C. H.; Laclare, J. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 159–62 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A storage ring designed for duty-cycle smoothing of an ~40 MeV linac beam is described. An energy-spread of only ~0.1% suffices for the coincidence-type experiments for which it is needed. This design is not basically achromatic but its performance is improved by suitably choosing the bending magnet second order field index β; it has also appreciably fewer elements than earlier broad-band designs. (auth)

28810 PERFORMANCE OF THE CEA LOW-BETA BYPASS. Averill, R.; Hofmann, A.; Little, R.; (and others) (Cambridge Electron Accelerator, Mass. Harvard Univ., Cambridge, Mass. Massachusetts Inst. of Tech., Cambridge). pp 163–5 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The effects of non-linear resonances on the operation of the low-beta bypass have been investigated. Effects of satellite stop bands have been made manageable by reducing the chromaticity to a value near zero using 30 sextupole magnets distributed around the ring. Non-linear fields in critical quadrupoles of the bypass reduce the effective aperture of the system to below the physical value. Satisfactory operation has been achieved with β_h = 7 cm and β_v = 22 cm, and further improvements in magnetic field quality should permit operation at even lower values of β. The beam size at the interaction point is measured by passing a fiber through the stored beam and observing the resulting bremsstrahlung. (auth)

28811 BEAM ENLARGEMENT WITH A HIGH FREQUENCY OSCILLATING QUADRUPOLE. Morton, P. L. (Stanford Univ., Calif.). pp 166-7 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

To achieve the maximum possible luminosity in electron or positron storage rings it may be necessary to increase the transverse emittance of the beam. In order not to swamp the transverse feedback system it is necessary to "blow up" the beam without affecting the position of the center of the beam. For this purpose a quadrupole oscillating at approximately twice the betatron oscillation frequency is placed in the storage ring magnet lattice. The particle dynamics with such a quadrupole in the lattice is discussed including the effects of fluctuations and nonlinearities and the possibility of modulating the strength or the oscillation frequency of the quadrupole field. (auth)

28812 TEST RESULTS: PULSED SUPERCONDUCTING SYNCHROTRON-TYPE DIPOLE MAGNETS. Gilbert, William S.; Meuser, Robert B.; Voelker, Ferdinand (Univ. of California, Berkeley). pp 206-11 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Seven 10-cm bore superconducting pulsed dipole magnets for synchrotron application have been built. The first three were random-wound; in the others, the conductor is arranged in an ordered array with radial helium coolant passages. Central fields of 2.7 T have been attained with no iron return yoke. In pulsed operation to 2.4 T at a rate of 0.4 T/s the losses were about as predicted. The newest magnet is wound with a simple cable, rolled to a square cross-section, and containing forty-nine .02-cm-diam wires. An improved insulation-ventilation system enables the space factor to be twice that of the preceding magnet. (auth)

28813 EXPERIMENTAL OBSERVATION OF BEAM BEHAVIOR IN THE ISR. Schnell, W. (CERN, Geneva). pp 291-4 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The high-intensity beam effects encountered at the CERN ISR including single (bunched) beam pulses and stacked beams are considered non-linear resonances; transverse instabilities at low frequencies; microwave instabilities; beam–beam interaction; clearing fields, anomalous decay and blow-up; and vacuum effects are discussed. (W.H.K.)

28814 COHERENT SPACE CHARGE PHENOMENA IN THE ISR. Huebner, K.; Keil, E.; Zotter, B. (CERN, Geneva). pp 295-7 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Coherent instabilities of bunched and coasting beams in the ISR are compared to theoretical predictions. The present phase space density is below the threshold for the longitudinal coherent instability which has not yet been observed in the ISR, while transverse instabilities have been seen and eliminated by the application of additional sextupole fields. (auth)

28815 CLEARING FIELDS OF THE ISR. Angerth, B.; Fischer, E.; Groebner, O. (CERN, Geneva). pp 298-300 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A system of clearing electrodes to prevent space charge neutralization due to ionization of the residual gas in the vacuum chamber by the beam protons is described. Experimental results are discussed including optimum clearing voltage settings, clearing efficiency, and beam decay rates as a function of the applied clearing voltage. (W.H.K.)

28816 SYNCHROTRON AND BETATRON INSTABILITIES OF STORED BEAMS IN THE CEA. Averill, R.; Hofmann, A.; Little, R.; (and others) (Cambridge Electron Accelerator, Mass. Harvard Univ., Cambridge, Mass. Massachusetts Inst. of Tech., Cambridge). pp 301-5 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Betatron and synchrotron oscillation instabilities have been observed with stored electron and positron beams in the CEA. Both types of instabilities seem to depend on the peak circulating current and to be independent of the circumferential fill factor. Both types of instabilities are observed as coherent displacement signals on beam displacement monitors. A short range bunch–bunch interaction is observed for betatron as well as synchrotron oscillation instabilities. Betatron instabilities, which are of the head–tail-type, have been eliminated up to peak currents of 150 mA with a system of distributed sextupoles. The effects of synchrotron oscillation instabilities have been reduced by operating the CEA during multicycle filling at the lowest possible rf-accelerating voltage. (auth)

28817 OBSERVATION OF THE HEAD-TAIL INSTABILITY AT THE CAMBRIDGE ELECTRON ACCELERATOR. Hofmann, A. (Cambridge Electron Accelerator, Mass. Harvard Univ., Cambridge, Mass. Massachusetts Inst. of Tech., Cambridge); Muelhaupt, G. pp 306-7 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The head–tail effect is discussed, and factors affecting the head–tail instability at CEA including the octupole field and chromaticity, bunch length, and beam energy are considered. (W.H.K.)

28818 NONLINEAR BEAM–BEAM EFFECT. Jejcic, A.; Le Duff, J. Paris Univ., Orsay, France). pp 354-6 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

An analytical approach to the non-linear space charge effects in electron–positron colliding beam rings is presented. In particular, the distribution function of the betatron frequencies is computed in some special cases of interest such as head-on collisions and uncomplete compensation with four beams. (auth)

28819 COHERENT BEAM BREAK-UP DUE TO SPACE CHARGE. Piwinski, A. (DESY, Hamburg). pp 357-9 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A mechanism is described which leads to a beam break-up in storage rings and which yields limiting currents in good agreement with some experiments made with the A.C.O. storage ring. (auth)

28820 PHASE MOTION STABILITY OF THE BUNCH IN A STORAGE RING DEPENDING ON THE FORM OF SYNCHROTRON FREQUENCY DISTRIBUTION FUNCTION. Karliner, M. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp 363-6 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The conditions of the phase stability, taking into account the nonlinearity of synchrotron oscillations in quasi-linear approximation, are considered. In this approximation for a nonmonotonous distribution function of synchrotron frequencies, the appearance of phase instability at "good" (according to the known criteria) tuning of the resonator is possible. (auth)

28821 TRANSVERSE STABILITY OF THE BUNCHED BEAM INTERACTING WITH THE LOW-Q-VALUE SYSTEM. Derbenev,

Ya. S.; Dikanskii, N. S.; Pestrikov, D. V. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp 370-1 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Results of an investigation of the stability of axial and axial–longitudinal collective excitations of a finite length bunch in a storage ring including the energy dependence of the betatron frequencies are presented. (W.H.K.)

28822 INCOHERENT SPACE CHARGE PHENOMENA IN THE ISR. Keil, E. (CERN, Geneva). pp 372-3 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

At high beam currents, the beam lifetime in the ISR is shorter than that expected from nuclear and Coulomb scattering in the residual gas. Two possible explanations for this observation are put forward: intra-beam scattering of the protons of one beam on each other driving them into non-linear resonances, and a slow stochastic instability, called Arnold diffusion, which is excited by neutralized regions in the ISR beam. (auth)

28823 OBSERVATION OF THE GEOMETRY OF COLLIDING PROTON–PROTON BEAMS BY MEANS OF BEAM–BEAM ELASTIC COLLISIONS. Barbiellini, G.; Bozzo, M.; Darriulat, P.; (and others) (Technische Hochschule, Aachen, Ger.). pp 431-4 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A system of nine magnetostrictive wire spark chamber telescopes for non-destructive observation of the geometry of the beam–beam collisions based on elastic scattering in the CERN ISR is described. Experimental results are discussed. The beam–beam elastic event rate has been typically of the order of 300 per second at 2.5×2.5 A^2 circulating beam currents. (W.H.K.)

28824 EXPERIENCE WITH COMPUTER CONTROL APPLIED TO THE CERN INTERSECTING STORAGE RINGS (ISR). de la Rive Box, M.; Groebner, O.; Kemp, D.; (and others) (CERN, Geneva). pp 439-43 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The computer system and its interfaces with the ISR and with operators are briefly discussed. In this framework the applications of the computer in the ISR activities are described. (auth)

28825 200-GeV INTERSECTING STORAGE ACCELERATORS. Blewett, John P. (Brookhaven National Lab., Upton, N. Y.). pp 501-4 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Preliminary design data are presented for a pair of 200-GeV intersecting storage accelerators (ISABELLE) using superconducting magnets. The AGS will be used as the injector for both rings. Methods are proposed for beam transfer and acceleration. Luminosities in excess of 10^{33} cm^{-2} sec^{-1} per meter of collision area should be achievable. (auth)

28826 BEAM CONTROL AND RF STACKING IN ISR. Hansen, S.; de Jonge, M. J. (CERN, Geneva). pp 505-7 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The equipment and the different programs used for RF stacking in the ISR are described. Since the high-power part has previously been described (F. A. Ferger, et al., USSR 2nd Nat. Conf. on Particle Accelerators, Moscow, Sept., 1970) emphasis is put on the low level system. Frequency and voltage programs, missing bunch phaselock, and suppressed bucket systems are described. Some of the results obtained during ISR running-in are discussed. (auth)

28827 DAMPING OF TRANSVERSE OSCILLATIONS IN THE ISR. Rochepeau, G.; Thorndahl, L.; Vaughan, A.; Zettler, C. (CERN, Geneva). pp 508-10 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A feedback system to remove horizontal injection errors in the ISR is described. The system treats the 20 bunches injected from the CPS individually. As the damping process extends over many revolutions (typically 100) the power needed to drive the kicker magnet is modest (30 kW). A different feedback system against resistive wall type instabilities of the stacked beam is mentioned. (auth)

28828 BEAM DUMPING AND SCRAPING IN THE CERN INTERSECTING STORAGE RINGS. Delizee, A.; Middelkopp, W. C.; Montague, B. W.; (and others) (CERN, Geneva). pp 511-14 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The high intensity of the beams stacked in the CERN ISR called for the design and construction of a system capable of dumping the beams before they hit the vacuum chamber under fault conditions and of concentrating the induced radioactivity into a small region. The dumping system of each ring consists of four air-core full-aperture pulsed magnets which deflect the beam vertically onto an absorber block. The systems for the two storage rings have worked correctly from the first ISR runs with repetitive or manual triggering. The automatic triggering required for the sudden need to eliminate a stacked beam is being completed. Scraping targets are required for protecting the injection kickers from the phase-displaced tail of the beam during stacking, and for removing low-density halos from the stack. The targets consist of scattering foils located in azimuth such that the scattered protons are mainly intercepted by the absorber block of the beam dumping system. (auth)

28829 CLOSED ORBIT MANIPULATION AND CORRECTION IN THE CERN ISR. Autin, B.; Bryant, P. J. (CERN, Geneva). pp 515-17 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The results from two different global methods of orbit correction are given together with descriptions of other beam manipulations involved in luminosity measurements. (auth)

28830 ADJUSTMENT OF THE WORKING LINES IN THE ISR. Gourber, J. P.; Henrichsen, K. N. (CERN, Geneva). pp 518-20 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The various adjustments of the betatron oscillation frequencies which have been made since the beginning of the ISR running-in period are described in relation with their global effects on the beam behavior. The effects of the correcting elements (poleface windings, sextupoles, etc.) have been measured and correction methods developed for the necessary shaping of the "working line" in the Q_H/Q_V diagram. (auth)

28831 COMPUTER CONTROLLED SYSTEM FOR THE FORECAST OF BEAM PARAMETERS IN THE CERN INTERSECTING STORAGE RINGS. Henrichsen, K. N.; Gourber, J. P. (CERN, Geneva). pp 521-2 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The described measurement and display system permits forecast of the ISR beam parameters. The measurements are performed in the reference magnet units connected in series with the main magnets. (auth)

28832 STABILITY OF A CLOSED PROTON BEAM IN AN IONIZED GAS. Dimov, G. I.; Shamovskii, V. G.; Chupriyanov, V. E. (Inst. of Nuclear Physics, Novosibirsk, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 10, 1662-5(Apr 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 10, 2098-2102(Oct 1971).

Experimental data on the effect of secondary charged particles on the stability of a closed proton beam in a storage ring are given together with qualitative explanations of the observed effects. Conditions are found for which a completely compensated (by secondary electrons) proton beam is stable when the number of particles in the track is close to the space-charge limit. (auth)

Experimental Facilities

Refer also to abstracts 29482 and 29732.

28833 (COO-1195-231) PRODUCTION OF NEUTRAL KAONS AND LAMBDAS FROM CHARGED KAON INTERACTIONS WITH COMPLEX NUCLEI. Banner, David Lee (Illinois Univ., Urbana). Jan 1972. Contract AT(11-1)-1195. 93p. Dep. NTIS. Thesis.

Measurements of the cross sections for the production of neutral kaons with momenta $\simeq$400 MeV/c and lambdas with momenta $\simeq$700 MeV/c from charged kaon interactions incident at 850 MeV/c on carbon, aluminum, copper, tin, and lead were made at the Argonne National Laboratory Zero-Gradient Synchrotron. The measurements were made in order to determine which complex nuclear targets produced the best "beams" of neutral kaons, for use in an experiment to observe the decay of neutral K mesons into $\pi^+\pi^-$. The cross sections are presented, and models for fitting the data, involving $A^{\frac{1}{3}}$- and $A^{\frac{2}{3}}$-parameterizations, are discussed. The K^0 and $\bar{K}^0$ cross sections are fit about equally well with an $A^{\frac{1}{3}}$- and $A^{\frac{2}{3}}$-parameterization. Monte Carlo computer codes were written to see whether the experimental cross sections could be understood on the basis of a simple impulse approximation model. Relative cross sections computed with the Monte Carlo codes agree reasonably well, after experimental cuts were included, with the experimental cross sections for K^0 and $\bar{K}^0$ production. The agreement is not very good for Λ production, but a possible explanation for the disagreement is discussed. For a fixed-length target, 7 cm long, copper is found to be best for producing the most intense "beams" of neutral kaons and lambdas. (auth)

28834 (IFVE-SEF-71-5) OPTIMUM LENGTH OF TARGETS. Denisov, S. P.; Stoyanova, D. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1971. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

The problem of choosing the thickness of the target which provides the minimum statistical error in experiments on total and absorption cross sections by measuring the attenuation of a beam of particles under conditions of "good" geometry is considered. (auth)

28835 (RHEL/R-234) PRECISION SHUNT WITH SMALL TEMPERATURE COEFFICIENT. Culliford, D. R. (Rutherford High Energy Lab., Chilton (England)). Dec 1971. 11p. Dep. NTIS (U. S. Sales Only). UK 15 pence.

The design, construction and testing of high current precision shunts used in conjunction with highly stabilized power supplies are discussed. Particular mention is made of methods of producing good end joints for the Zeranin wire used. (auth)

28836 POSITRON ACCELERATION USING A 30-MeV ELECTRON LINEAR ACCELERATOR. Saito, Teijiro; Nakada, Yoshiaki; Nakada, Akira (Tohoku Univ., Sendai). Jap. J. Appl. Phys.; 11: No. 3, 396-403(Mar 1972).

Positron generation at the end of the accelerator, positron acceleration after the positron converter, and the annihilation photons were studied using a 30-MeV electron linear accelerator. In the positron generation, it was found that a thickness of 1.5 to 2.0 mm is most efficient for a tantalum converter in this energy region. In the case of positron acceleration, the positron energy can be varied from 8 to 22 MeV. A ratio of the positron current within an energy spread of 3% to the total electron current was estimated to be of the order of 10^{-7}. The spectra of the annihilation photons were obtained by a NaI (Tl) crystal spectrometer. (14 figures) (auth)

28837 SOME ASPECTS OF DOSIMETRY WITH A 4 MV LINEAR ACCELERATOR. Castro, Victoria G.; Kopenhaver, James F. (Albert Einstein Medical Center, Philadelphia). Radiology; 102: No. 3, 691-8(Mar 1972).

A performance study of the Varian Clinac 4 linear accelerator is presented. Previously published data for dosimetry with 4 MV x-ray units differ by 2% or more from those obtained with the softer radiation of the Clinac 4. Small differences were found between the data provided by the manufacture and the data obtained experimentally, probably due either to experimental differences or to characteristics of the unit tested. Good agreement was found between percent depth doses for circular and equivalent square fields, thereby allowing data originally developed for square fields to be applied to circular fields. (auth)

28838 ADVANCES IN SECONDARY BEAMS AT THE 70 GeV IHEP PROTON SYNCHROTRON. Eremenko, E. V.; Galyaev, N. A.; Golovnya, N. I.; (and others) (Inst. for High Energy Physics, Serpukhov, USSR). pp 17-20 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Beam channels recently constructed at the IHEP synchrotron are described. (W.H.K.)

28839 HIGH FIELD IN A MODEL SUPERCONDUCTING RF SEPARATOR AT 1.3 GHz. Carne, A.; Bendall, R. G.; Brady, B. G.; Sidlow, R.; Kustom, R. L. (Rutherford High Energy Lab., Chilton, Eng.). pp 248-52 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Superconducting RF separators proposed at the Rutherford Laboratory are planned to operate up to a maximum mean deflecting field E_0 = 3.6 MV/m. Tests have been carried out on a 2-cell full scale model (with lead plated on a copper substrate) to prove the structure can operate at or near the design fields. Fields up to E_0 = 2.1 MV/m, corresponding to 2.74 MV/m on the design structure, have been obtained. (auth)

28840 EXPERIMENTAL INVESTIGATION OF SUPERCONDUCTING Nb DEFLECTING CAVITIES. Bauer, W.; Citron, A.; Dammertz, G.; (and others) (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). pp 253-7 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Experimental results of measurements of Q-values and peak fields obtained at 1.8 K in several niobium deflecting test cavities are presented. After chemical polishing the cavities typically showed peak fields of about 250 G at improvement factors of a few 10^4. The effect of baking in an UHV-furnace or anodizing the surface was investigated but it showed no marked improvement. Fabrication techniques for the cavities and methods of surface treatment are described, and the final deflector geometry is shown. The results indicate that a superconducting RF particle separator with reasonable performance, say $E_0 \simeq 2$ MV/m, can be constructed. (auth)

28841 FEEDBACK IN RF-SEPARATORS. Alferov, V. N.; Vishnevskaya, A. M.; Vladimirtsov, M. B.; (and others) (Inst. of High Energy Physics, Serpukhov, USSR). pp 258-61 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

It has been shown that the feedback in the RF-separator increases the particle deflection by ~15%. These operating conditions were studied with the 1 m model of the deflector. The 60 MW power level (415 kV/cm) was achieved for a pulse duration of 10 μs. (auth)

28842 SOME NEW POSSIBILITIES FOR RF-SEPARATION AT CERN. Bernard, Ph.; Lengeler, H.; Prelaz, J. Cl. (CERN, Geneva). pp 269-71 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A number of improvements have been performed on the RF-separator, enabling more sophisticated applications and an extension of the separation towards lower and higher momenta. Mesons (π^-) have been separated at 4 GeV/c by using the method of phase slip in a single deflector. By combining the phase slip method with the normal two-cavity separation, rejection of deuterons during K^+-separation between 6 and 16 GeV/c has been achieved. Separation of the 16 GeV/c K^- from π^- has been successfully performed by using an inter-cavity distance of only

22 m. This shows that separation with phase differences between wanted and unwanted particles as low as 30^0 is possible, and, for a given inter-cavity distance, allows separation to much higher momenta than performed up to now. (auth)

28843 THREE-COMPONENT SEPARATION OF ULTRA-HIGH ENERGY PARTICLES. Valdner, O. A.; Glazkov, A. A. (Moscow Physical Engineering Inst.). pp 272-4 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Some theoretical problems of separation of ultra-high energy particles are considered. The separation of wanted kinds of particles in a three-cavity separator for beams with two kinds of unwanted particles is investigated as a function of intercavity distances for a wide range of particle momenta up to 200 CeV/c. When four cavities are used, it is possible to separate heavy particles in beams with antiprotons, kaons, and pions. A computer program was written to calculate muon contamination in pure beams of ultra-high energy particles. (auth)

28844 RF-LOSSES OF SUPERCONDUCTING NIOBIUM-CAVITIES COATED WITH Nb_2O_5. Kneisel, P. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.); Stoltz, O.; Halbritter, J.; (and others). pp 275-7 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

Measurements on anodized niobium-cavities have been carried out in the GHz-region. Residual surface resistances of 10^{-8} Ohm at S-band frequencies and magnetic peak fields of 80 mT at X-band frequencies were achieved without firing the cavities in an UHV-furnace. Also, the dense coating of niobium with Nb_2O_5 seems to prevent aging of the superconducting surface. (auth)

28845 MUON GUIDE MADE OF UNITS OF MAGNETIZED IRON. Bondarenko, G. B. (Moscow Physical-Engineering Inst.); Glukhikh, V. A.; Dobretzov, Yu, P.; (and others). pp 282-5 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The muon guide, made of magnetized iron, that was designed for studying the processes of muon production in N + N collisions to search for intermediate bosons at the IHEP accelerator is described. According to the experimental requirements, the muon guide is to provide measurements of muon energy spectra in the energy range of 10 to 30 GeV as well as measurements of the muon slowing down to a stop, the purpose of which is muon polarization over symmetry of muon decay. (W.H.K.)

28846 HARDWARE FOR A COMPUTER CONTROL SYSTEM FOR THE 1.5m BUBBLE CHAMBER BEAMLINE AT NIMROD. Lane, H.; Moir, J.; Morgan, R. H. C.; (and others) (Rutherford High Energy Lab., Chilton, Eng.). pp 435-6 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A control and acquisition system based on a PDP-8 and Camac for the K9 separated bubble chamber beam is described. Multiplexed control of magnets and collimators is discussed. (auth)

28847 INITIAL EXPERIENCE OF THE USE OF INTERPRETIVE SOFTWARE FOR BEAMLINE CONTROL. Adams, P.; Morgan, R. H. C.; Smith, W. A.; Atchison, F.; Kerr, J. C. (Rutherford High Energy Lab., Chilton, Eng.). pp 437-8 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

A computer control system using a high level language interpreter has recently been installed on the K9 beamline at the Rutherford Laboratory. The initial experience gained with this system is described from the users' point of view, with a description of the facilities that the system provides. The flexibility of the system is discussed with reference to the various modes of running the beamline. Finally there is a description of the performance of the interpreter itself with particular reference to program execution time. (auth)

28848 EXPERIMENTAL OBSERVATION ON LMN OF AN EFFECT RELATED TO THE NUCLEAR DYNAMIC POLARIZATION. Montelatici, V. Tomassetti, G. (CNEN, Frascati, Italy). Lett. Nuovo Cim.; 3: No. 10, 391-4(4 Mar 1972).

A study of the cross relaxation between the "near protons" and the "distant protons" according to the phenomenological shell-of-influence model developed by Jeffries and co-workers [T. J. Schmugge, et. al., Phys. Rev., 139, A 1785(1965)] for the dynamic polarization in LMN by the solid effect is described. A block diagram of the apparatus used to detect the proton magnetic resonance is included. (W.H.K.)

28849 ADJACENT FIELD SEPARATION FOR HOMOGENEOUS DOSAGE AT A GIVEN DEPTH: DATA FOR THE 8MV (MEVATRON 8) LINEAR ACCELERATOR. Agarwal, Suresh K.; Marks, Richard D. Jr.; Constable, William C. (Univ. of Virginia, Charlottesville). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 114: No. 3, 623-30(Mar 1972).

A study to determine the gap or space that must be left between adjacent or opposed x-radiation fields for radiotherapy to cover the entire volume suspected of harboring tumor cells is given. The study was undertaken specifically for an 8-MeV linac facility. Three different methods were used to determine the field separation to ensure homogeneity of dosage at a given depth including geometric calculation, a dosimetric model using selenium diode and water phantom, and a dosimetric model using Kodak industrial M film in a masonite wood phantom. Results are presented and discussed. (W.H.K.)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

Cosmic Radiation

Refer also to abstracts 29022, 29030, 29054, 29140, 29552, and 29944.

28850 (N-71-36129) THEORETICAL INTERPRETATION OF COSMIC RAY PHENOMENA. Final Report. (Aeronautical Research Associates of Princeton, Inc., N. J.). Jul 1971. Contract NAS9-9515. 43p. (NASA-CR-115178). NTIS.

Several numerical and analytical approximation techniques for obtaining solutions to cosmic-ray flux equations were developed. The numerical Laplace transform inversion and the analytic extension methods seem the most promising. The cosmic-ray transport in turbulent interplanetary and interstellar plasmas is also discussed. (auth) (STAR)

28851 (N-72-13757) BALLOON MEASUREMENTS OF THE ENERGY SPECTRUM OF COSMIC ELECTRONS BETWEEN 1 GeV AND 25 GeV. Earl, James A.; Neely, Dennis E.; Rygg, Thomas A. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Sep 1971. Contract Nonr-710(19). 42p. (NASA-CR-124735). NTIS.

During three balloon flights made in 1966 and 1967, cosmic elpctrons were investigated with the aid of a hodoscope detector that provided extensive and detailed information on each cosmic-ray event triggering the apparatus. Similar information obtained during calibration exposures to protons and pions as well as to electrons was used to provide identification of cosmic electrons and to determine their energies. Differential primary electron intensities measured in the range from 1 to 25 GeV were substantially larger than some earlier measurements. Taken in conjunction with existing measurements at energies above 100 GeV, this indicates that the energy spectrum of cosmic electrons is steeper than that of cosmic-ray nuclei and, consequently, suggests that Compton/synchrotron energy loss plays a significant role in shaping the electron spectrum. (auth) (STAR)

28852 GENERALIZED OPERATOR OF AMBIPOLAR DIFFUSION OF CHARGED PARTICLES IN THE F REGION OF THE IONOSPHERE. Fatkullin, M. N.; Sitnov, Yu. S. (Inst. of Terrestial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 5, 788-90(1971). (In Russian).

Oxygen ions O^+ predominate at altitudes, such as those of the F2 layer. In a consideration of the processes of ambipolar diffusion, only the diffusion of charged particles along magnetic lines of force are taken into account. For finding the ambipolar diffusion operator, D_d, the divergence of diffusion in the general mode is calculated using a dipolar system of coordinates. (K.S.W.)

28853 DETERMINATION OF THE SEA-LEVEL NEUTRON FLUX. Johnston, Richard Lindy. Washington, D. C.; Catholic Univ. of America (1971). 70p. University Microfilms Order No. 72-2965.

Thesis.

The exponent in the power law approximation of the differential energy spectrum of neutrons at sea level was obtained and found to be 1.4 + 0.3. The method used was to observe the knock-on protons in a large-volume spark chamber at the Catholic University of America, Washington, D. C. The range and zenith-angle distributions of the protons using the results obtained above were calculated using the available (n,p) differential cross sections and assuming a neutron flux dependence of $\cos^4\theta$, θ being the angle with respect to the zenith. The calculated distributions were compared and found to be in agreement with the observed range and zenith-angle distributions. (Diss. Abstr. Int., B)

28854 ABSOLUTE MEASUREMENT OF THE VERTICAL COSMIC-RAY MUON INTENSITY NEAR 1 GeV/c AT 12°N. De, A. K.; Ghosh, P.; Mitra, S.; Bhattacharya, P. C.; Das, A. K. (University Coll. of Science, Calcutta). Phys. Rev., D; 5: No. 5, 1068-72(1 Mar 1972).

The absolute vertical cosmic-ray muon intensity at sea level at 12°N was measured with a range spectrometer similar to that used by Allkofer et al. and by Jokisch. The integral intensity amounts to 6.86×10^{-3} cm^{-2} sr^{-1} sec^{-1} at 0.954 GeV/c which is 10.3% lower than that of Allkofer et al. and 10.6% higher than that of Rossi, generally used as the normalization point for muon spectra. The results are in favor of experimental findings of Allkofer et al. The decrease in intensity may be explained in terms of the geomagnetic latitude effect. (auth)

28855 COSMIC-RAY PROTON AND HELIUM SPECTRA ABOVE 50 GeV. Ryan, M. J.; Ormes, J. F.; Balasubrahmanyan, V. K. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev. Lett.; 28: No. 15, 985-8(10 Apr 1972).

Differential energy spectra of cosmic-ray protons and He nuclei were measured for the first time by an ionization spectrometer flown at balloon altitudes. The energy range extended from 50 to >1000 GeV. The observed differential intensities can be represented with power-law spectra with a slope of -2.75 ± 0.03 for protons and of -2.77 ± 0.05 for He nuclei. The proton-to-He ratio is 26 ± 3 at 40 GeV/nucleon and is constant within errors up to 400 GeV/nucleon. (auth)

28856 CORRELATION ANALYSIS OF THE INTENSITY OF GALACTIC COSMIC RAYS IN SPACE AND ON THE EARTH. Golynskaya, R. M.; Pereslegina, N. V. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 4, 516-20(Jul-Aug 1971).

Translated from Kosm. Issled.; 9: No. 4, 565-9(Jul-Aug 1971).

The evaluation of experimental data of the sliding correlation method is applied to obtain information about the dynamics of galactic cosmic rays and correlated processes and conclusions are drawn about the time and spatial variations of the processes. The method consists of calculating the mutual correlation functions with a certain constant step. The correlation functions overlap one another in a certain sense, enabling the dynamics of the process to be followed. (J.C.W.)

28857 CHARGE RATIO OF MUONS AT SEA LEVEL IN THE RANGE 5 TO 600 GeV/c. Nandi, B. C.; Sinha, M. S. (Regional Engineering Coll., Durgapur, India). Nucl. Phys.; B40: 289-97(1972).

The charge ratio of near-vertical muons was measured by the Durgapur cosmic-ray spectrograph. The mean value over the whole momentum range is 1.28 ± 0.01. In the region of 50 GeV/c there is the suggestion of a slight reduction (to ~1.21), and above 100 GeV/c the ratio appears to increase slightly. Possible interpretations are discussed. (auth)

28858 INVESTIGATION OF THE ABSOLUTE INTENSITY OF MUONS AT SEA-LEVEL. Crookes, J. N.; Rastin, B. C. (Univ. of Nottingham, Eng.). Nucl. Phys.; B39: No. 1, 493-508(1972).

The absolute intensity of muons at sea level was measured using a telescope consisting of two arrays of crossed neon flash tube detectors triggered by a four-fold Geiger counter coincidence. The use of the flash tube information to delineate the particle trajectory has enabled the acceptance solid angle to be defined with an error of only 0.5%. All particles accepted by the telescope were required to penetrate a 10.3 cm thickness of lead which eliminated the soft component and ensured that only muons were detected. The total thickness of absorber penetrated by the triggering particle including all the material of the apparatus as well as that above the experimental site was 184.7 g cm^{-2} of lead which corresponded to a lower momentum cutoff of 0.35 GeV/c. These intensity measurements have been made with the axial direction of the telescope in the magnetic N-S azimuth for zenith angles of 0°, 45°, 60° and 80°. A comparison with the universally accepted value of the vertical absolute intensity for muons at sea-level given by Rossi from the work of Greisen is included and this shows that the present result ($(9.13 \pm 0.12) \times 10^{-3}$ cm^{-2} s^{-1} sr^{-1}) is higher by 9%. General agreement with this conclusion is provided by Allkofer et al. although the latter authors claim the Greisen result to be too low by some 26%. A tentative comparison between the present result and that obtained by Allkofer et al. is also given although due to the difference in the lower momentum cutoffs associated with the two instruments use has to be made of the integral spectrum measured by Allkofer and Clausen, the accuracy of which allows only qualitative agreement to be claimed. The variation of absolute intensity with zenith angle obtained in this work is shown to be adequately represented by the expression $I_\Theta = 9.13 \times 10^{-3} \cos^{2.16}\Theta$ for angles less than 75°. Since no other absolute intensity measurements have been performed for zenith angles in the range 0° to 85° a comparison is made of the exponent and this indicates the existence of good agreement between the results from the various workers. The data at large zenith angles was analyzed separately and this is presented together with the work of Jakeman and Wilson. (auth)

Stars

Refer also to abstracts 28907, 29737, 29740, and 29742.

28859 CHANGES OF POLARIZATION OF RED VARIABLES OF HIGH LUMINOSITY. II. Dombrovskii, V. A.; Polyakova, T. A.; Yakovleva, V. A. Uch. Zap. Leningrad. Gos. Univ., No. 359, Ser. Mat. Nauk; No. 47, 25-32(1971). (In Russian).

Results of polarimetric and photometric observations of red variables of high luminosity (μ Cep, R Sct, V CVn, X Her, AK Peg, and S UMa) are given. The behavior of polarization of the stars is different. For some of them, a correlation exists between the changes of polarization, brightness, and color. (auth)

28860 SPECTRAL OBSERVATIONS OF M-STARS IN THE PHOTOGRAPHIC INFRARED REGION. Derviz, T. E. Uch. Zap. Leningrad. Gos. Univ., No. 359, Ser. Mat. Nauk; No. 47, 52-7(1971). (In Russian).

The grating coude spectrograph of the 18" reflector A3T-3 is described. Spectrograms in the photographic infrared region of a number of M-type stars were obtained. Line wavelengths and identifications are given. (auth)

28861 OBSERVING PROGRAMS FOR EARLY-TYPE STARS WITH EXTENDED ATMOSPHERES. Underhill, Anne B. (State Univ., Utrecht). Eur. S. Observ., Bull.; 33-8(Jun 1971).

The early-type stars with extended atmospheres can be divided into three classes including extreme cases, moderate cases, and border-line cases. It is important with shell stars to have a homogeneous set of spectrograms of the best possible spectral purity covering a long time range (20 years or more). Significant theoretical advances with regard to Wolf–Rayet stars probably cannot take place without the stimulus given by a set of homogeneous spectrophotometric data. There are 53 supergiants of types A2 to O9 with southerly declinations and apparent magnitudes brighter than 6.6 mag. Various problems to be studied in connection with main-sequence stars are considered. (IAA)

28862 INTENSITY MEASUREMENTS AND RELATIVE BAND STRENGTHS OF THE BANDS OF (B → X) SYSTEM OF LANTHANUM OXIDE. Murthy, N. S.; Murthy, B. N. (Univ. of Mysore, India). J. Phys., B (London); 5: No. 3, 714-19(Mar 1972).

Relative integrated intensities for the 40 bands of the (B → X) system of lanthanum oxide were measured by the technique of photographic photometry. A Morse model was employed to compute the Franck–Condon factors and the r-centroids. The variation of the electronic transition moment $R_e(r)$ with the internuclear separation r was found to be $R_e(r) = \text{const} \times \exp(-1.98r)$ in the range 1.643 Å < r < 1.995 Å. Smoothed relative band strengths were derived for the 27 bands. Effective vibrational temperature of the source was determined. (auth)

28863 $^7Li(p,\alpha)^4He$ CROSS-SECTION AT LOW ENERGIES. Barker, F. C. (Australian National Univ., Canberra). Astrophys. J.; 173: No. 2, 477-80(15 Apr 1972).

Values of the S factor for the $^7Li(p,\alpha)^4He$ reaction at stellar energies are obtained by extrapolation, using an R-matrix fit to experimental data at higher energies that takes account of levels in the compound nucleus ^8Be. (auth)

28864 NATURE OF THE HERBIG Ae- AND Be-TYPE STARS ASSOCIATED WITH NEBULOSITY. Strom, S. E. (State Univ. of New York, Stony Brook); Strom, K. M.; Yost, J.; Carrasco, L.; Grasdalen, G. Astrophys. J.; 173: No. 2, 353-66(15 Apr 1972).

A quantitative spectrophotometric study of the Herbig Ae and Be stars associated with nebulosity demonstrates that the majority have surface gravities appropriate to pre-main-sequence stars while the remainder have surface gravities characteristic of the zero-age main sequence. This evidence, along with their gross spectroscopic and photometric similarity to T Tauri-like stars and the fact that all these stars appear to be surrounded by circumstellar dust, places them among the youngest known stellar objects. The geometry of the circumstellar shells is discussed and the evidence seems to favor a nonspherical, possibly disk-like shape. Finally, photographs taken with a 1-μ image-tube system reveal a large number of red stellar objects surrounding many of these stars. This suggests that the Herbig Ae and Be objects may be the brightest representatives of very recently formed stellar groups. (auth)

28865 CENTRAL STAR OF NGC 1514. Greenstein, Jesse L. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.) Astrophys. J.; 173: No. 2, 367-75(15 Apr 1972).

The large planetary nebula NGC 1514 has a central star classified as A0; the star's continuum was known to be composite. Coudé spectra show the presence of stellar He II absorption, making it possible to resolve the stellar continuum into a horizontal-branch A star and a visually subluminous O star. Spectrophotometry of Balmer lines gives the surface gravity of the HB A star and thus its luminosity as $M_v = +0.8$; the O star has $M_v = +2.8$. If one adopts the parameters of the nebula from Kohoutek, the ultraviolet luminosity of the O star requires $T \approx 100{,}000°K$, and $M_b = -3.8$, typical of a normal planetary nucleus. The velocity of the A star is constant, near $+48 \pm 2$ km s^{-1}; a redetermination of the nebular velocity gives accordant results, $+41 \pm 5$ km s^{-1}. (auth)

28866 VELOCITY, REDSHIFT, AND PRESSURE SHIFT OF VAN MAANEN 2. Greenstein, Jesse L. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Astrophys. J.; 173: No. 2, 377-84(15 Apr 1972).

The perspective acceleration of the cool white dwarf van Maanen 2 has been measured by van de Kamp. He predicts a radial velocity of +160 km s^{-1}. With probable Einstein shift, the expected Doppler shift of +200 km s^{-1} contrasts sharply with the newly measured velocity of Ca II, $+39 \pm 4$ km s^{-1} from 15 spectra. The H-line shows a velocity $+29 \pm 7$ km s^{-1} larger than the K-line. A tentative explanation suggested is extreme pressure broadening and the violet shift found in the laboratory for resonance lines of the alkalis with helium perturbers. The relative density, estimated from analogous transitions in the laboratory, is about 50, i.e., a pressure near 1000 atmospheres, in agreement with Weidemann's hydrogen- and metal-poor model. There is an apparent additional negative shift of the blended Fe I lines in the ultraviolet. (auth)

28867 FINAL EVOLUTION OF A LOW-MASS STAR. II. Rose, William K.; Smith, Richard L. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 173: No. 2, 385-91(15 Apr 1972).

Calculations are presented that describe the physical properties of the static envelopes of a luminous red giant and an advanced thermal-relaxation oscillation. The thermal-relaxation oscillation produces a sufficiently high luminosity at the base of the convective envelope that hydrostatic equilibrium becomes impossible. (auth)

28868 HYDROSTATIC OXYGEN BURNING IN STARS. I. OXYGEN STARS. Arnett, W. David (Inst. of Theoretical Astronomy, Cambridge, Eng. Rice Univ., Houston, Tex. Univ. of Texas, Austin). Astrophys. J.; 173: No. 2, 393-400(15 Apr 1972).

The general properties of oxygen stars ($M/M_\odot$ = 2, 4, 8, and 16), up to and during core oxygen burning, are presented. The reasons for these properties are discussed quantitatively. A "single-zone" approximation for typical conditions during hydrostatic oxygen burning is developed which involves balanced power from $^{16}O + {}^{16}O$ energy generation and from neutrino energy loss. Some implications for nucleosynthesis theory are discussed. (auth)

28869 NATURE OF THE HORIZONTAL BRANCH. II. EXTREMELY BLUE HALO STARS: A THEORETICAL VIEWPOINT. Faulkner, John (Univ. of California, Santa Cruz). Astrophys. J.; 173: No. 2, 401-4(15 Apr 1972).

It is shown that Greenstein's extremely blue sequence of halo subdwarfs may be entirely consistent with the theory of the horizontal branch in globular clusters. The newly discovered halo stars are the descendants of red giants that have lost so much envelope mass that they proceed, after the helium flash, to this high-temperature extension of the usual horizontal branch. Observed and predicted values of log (L/M) provides a quantitative test of the theory, giving provisional information on the red-giant progenitor core masses. (auth)

28870 EXPLICIT CLOSED-FORM RESULT FOR THE DISCRETE EIGENVALUE IN STUDIES OF POLARIZED LIGHT. Siewert, C. E.; Burniston, E. E. (North Carolina State Univ., Raleigh). Astrophys. J.; 173: No. 2, 405-6(15 Apr 1972).

An exact closed-form result for the discrete eigenvalue pertinent to the combination of Rayleigh and isotropic scattering of polarized light is given. (auth)

28871 HYDROMAGNETIC STABILITY OF A STRATIFIED ATMOSPHERE FLOWING OVER A LIQUID. Talwar, S. P. (Langley Research Center, Hampton, Va.). Astrophys. J.; 173: No. 2, 407-21(15 Apr 1972).

The stability of an isothermal stratified plasma atmosphere flowing uniformly over an infinitely conducting liquid along an ambient magnetic field is investigated by the normal-mode analysis. The horizontal magnetic field is assumed uniform in the liquid but stratified (as to render Alfvén velocity constant) in the atmosphere. The dispersion relation obtained is discussed for parallel and transverse propagation for a static configuration, with the atmosphere regarded as coupled or uncoupled with the liquid below. Finally, the destabilizing effect of uniform slippage of the atmosphere is studied in the idealization that it is an incompressible hydromagnetic fluid. (auth)

28872 WHITE DWARFS. International Astronomical Union Symposium No. 42 Held at St. Andrews, Scotland, August 11–13, 1970. Luyten, W. J. (ed.). Dordrecht, Netherlands; D. Reidel Publishing Company (1971). 170p. f 34.-. (CONF-700855).

The 25 papers presented reflect observational and theoretical work in roughly equal numbers. This being the first and only conference held on the subject, it gives not only a completely up-to-date picture of the observational and theoretical aspects of white dwarfs, but also describes the entire history of the field from 1918, its beginning, onward. (W.D.M.)

28873 CEPHEID EVOLUTIONARY PHASE IN GLOBULAR CLUSTERS. Kukarkin, B. V.; Voroshilov, Yu. V. (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 861-2(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 1087-9(Sep-Oct 1971).

A comparison between the surface-density gradients of the Cepheids and RR Lyrae stars in globular clusters indicates that the Cepheids definitely are more massive. This result conflicts with Schwarzschild and Härm's views regarding the Cepheid evolutionary phase in globular clusters. (auth)

28874 BINARY AND MULTIPLE STARS IN FOUR FIELDS IN TAURUS. Bronnikova, N. M.; Sazonova, L. V. (Central Astronomical Observatory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 863-6(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 1089-94(Sep-Oct 1971).

Proper motions determined by Bronnikova were used to identify wide groups of stars in four fields in Taurus. The probability that these double and multiple systems are real was estimated from an equation given by Deich. The 36 most probable systems are tabulated. Twenty-one of the systems in the Taurus fields are included in the Lick double-star catalog; nine of these are among the 36 systems of high probability. Equatorial coordinates were computed for the Lick stars and, when possible, the separation and position angle of the components. The corresponding rms errors were: $\sigma_\alpha = \pm 0.02^s$, $\sigma_\delta = \pm 0.3''$, $\sigma_r = \pm 0.07''$, $\sigma_p = \pm 2°$. (auth)

28875 STARK BROADENING OF Si II AND Si III LINES. Yukov, E. A. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 867-8(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 1094-6(Sep-Oct 1971).

The Stark broadening of the Si II and Si III lines observed in certain peculiar stellar spectra is discussed. Calculations are performed in the collisional approximation with allowance for Coulomb interaction. Values are tabulated for the linewidth, shift, quadratic Stark-effect constant, and oscillator strength of several transitions. (auth)

28876 STABILITY OF AN INHOMOGENEOUS SPHERICALLY SYMMETRIC SYSTEM OF ROTATING MASSES. Fridman, A. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Novosibirsk, USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 720-7(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 910-21(Sep-Oct 1971).

An analysis was made of Einstein's model of a globular star cluster as a spherically symmetric system of masses rotating in circular trajectories. An r^{-2} law for the macroscopic density distribution of the particles was adopted, in accordance with observational evidence. The stability of such a system against arbitrary perturbations is proved in the Newtonian approximation. (auth)

28877 FORMATION OF NEBULAE BY WOLF–RAYET STARS. Avedisova, V. S. (Astronomical Council, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 708-13(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 894-901(Sep-Oct 1971).

The motion of the interstellar gas swept from the space surrounding a Wolf–Rayet star by its stellar wind can be represented by a pair of similarity solutions, corresponding to the adiabatic phase of shock-wave motion and an envelope phase accompanied by strong radiation. The behavior of the physical parameters within the gas flow is calculated for both phases. The adiabatic motion would have a high temperature and low density behind the shock front, and presumably would be unobservable because of the low emission measure and the remoteness of WR stars from the Sun. For typical densities of the galactic interstellar gas, the shock wave would be able to travel several parsecs before it is appreciably retarded and an observable envelope is formed. An equation is derived relating the circumstellar gas density and the power of mass loss by the star to the size and expansion rate of the envelope observed today. The magnetic field of the interstellar medium would be incapable of producing the observed ellipsoidality of the envelopes for plausible values of the field strength. The relations derived here are used to estimate the age of the nebula NGC 6888 and the power of mass outflow from the central star. (auth)

28878 SPECTRA OF THE STRONG FLARE OF AD LEONIS ON MARCH 2, 1970. Gershberg, R. E.; Shakhovskaya, N. I. (Crimean Astrophysical Observatory, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 737-40(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 934-8(Sep-Oct 1971).

Two spectrograms at 150-Å/mm dispersion were obtained with the 2.6-m Shain reflector during a strong flare of AD Leo on March 2, 1970. There was only a small discontinuity in the Balmer emission near maximum light: $D_B \gtrsim 0.2$. The measured equivalent widths and relative intensities of the emission lines were similar to those found for other strong flares of UV Ceti-type stars. In both of the AD Leo spectrograms the linewidths were ≈10 Å, so that the ratio $\Delta\lambda/\lambda$ did not remain constant for the Balmer lines from Hα to Hε. The first spectrogram, obtained near maximum light, exhibited an asymmetric enhancement of the red wing in some of the emission-line profiles; the second flare spectrogram showed no profile asymmetry, but the profiles had flatter peaks and a slight depression in intensity was suspected at the center of some of them. (auth)

28879 HELIUM ABUNDANCE ANOMALIES ON THE SURFACE OF THE SILICON Ap STAR CU VIRGINIS. Khokhlova, V. L. (Astronomical Council, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 741-3(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 939-41(Sep-Oct 1971).

The intensity variation of the He lines in the spectrum of the silicon Ap star Cu Vir is discussed. It is concluded that the variation results from the presence of two regions on the stellar surface, one with a normal helium abundance, the other with a tenfold deficiency of helium. (auth)

28880 TEMPERATURE SCALE FOR PECULIAR AND METAL-LINE STARS. Glagolevskii, Yu. V.; Leushin, V. V.; Kozlova, K. I.; Chunakova, N. M. (Special Astrophysical Observatory, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 744-50 (Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 942-50(Sep-Oct 1971).

A temperature scale was obtained for a system of quantitative spectral types Sp(K) for peculiar and metal-line stars. The excitation and ionization temperatures T_e and T_i were determined by the method of curves of growth from spectra of 15-Å/mm dispersion. The temperature dependence of Sp(K) for the Ap and Am stars resembled the corresponding dependence for normal stars in the MK system. Effective temperatures T_{eff} were calculated from T_e and T_i by using the average ratios between them for normal stars. The T_{eff} scale obtained for the Sp(K) system was close to the corresponding scale for normal stars; the maximum difference, Sp(K) – Sp(MK) = +1.4, occurs for late-type Ap and Am stars. (auth)

28881 DETERMINATION OF THE PHOTOMETRIC ORBITAL ELEMENTS OF ECLIPSING BINARIES BY THE DIRECT METHOD. Lavrov, M. I. (Kazan State Univ.). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 451-5(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 951-6(Sep-Oct 1971).

A description is given of the mathematical principles and a program for computing photometric orbital elements by the direct method. The light curves of AT Peg and W Del provide a successful test of the method. The concept of an error ellipsoid is introduced, and the possibilities of using it to evaluate the probable errors in the elements are discussed. (auth)

28882 LUMINOSITY FUNCTIONS FOR THE STARS IN THE PLEIADES CLUSTER. Kholopov, P. N.; Artyukhina, N. M. (Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 760-5(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 962-8(Sep-Oct 1971).

Luminosity functions were derived for the stars brighter than 18.0 mpg ($M_{pg} = +12.3$) in the nuclear and coronal regions of the Pleiades cluster. Possible cluster members brighter than 15m were identified by their proper motions. All members of the Pleiades fainter than 14.2 mpg are flare variables, and their magnitudes at minimum brightness were used to derive the luminosity functions for the range 14.0 to 18.0 mpg. The complete luminosity function for all Pleiades stars has a deep minimum near $M_{pg} = +10$. (auth)

28883 VELOCITY DISTRIBUTION FUNCTION FOR STARS BELONGING TO CLUSTERS. Kaliberda, V. S. (Leningrad State Univ.). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 766-70(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 969-75(Sep-Oct 1971).

Velocity distribution functions were derived for stars in non-

rotating systems. Two cases were considered: (A) the system comprises stars of mass m and m/2; and (B) it comprises stars of mass m and 2m. The effects of multiple stellar encounters were taken into account. It was found that the spread in mass tends to increase the escape rate. (auth)

28884 SLOW ROTATION OF WHITE DWARFS AND BARYON STARS. Papoyan, V. V.; Sedrakyan, D. M.; Chubaryan, E. V. (Erevan State Univ. Byurakan Astrophysical Observatory, Erevan). Astrophysics (Eng. Transl.); 5: No. 3, 192-7(Jul-Sep 1969). Translated from Astrofizika; 5: No. 3, 415-24(1969).

Rotation of white dwarfs and baryon stars is discussed in the first-order approximation in the angular velocity Ω. The radial distribution of the nondiagonal component of the metric and of the relativistic moment of inertia is established, and the rotational energy is estimated. The results are also valid in the second approximation in Ω. The results of a numerical integration are given. Transitions between different states of hyperon stars with different energies are discussed, in which the total number of baryons and the angular momentum are conserved. It is shown that, owing to the mass differences, the transitions are accompanied by a release of about 10^{52} erg. Energy of the same order is released due to the reduction in the rotational energy. It is probable that this energy ensures, on the one hand the observed luminosity, and on the other leads to the pulsation of the object under consideration. (auth)

28885 MARKOV PROCESSES AND STELLAR DYNAMICS. II. Tscharnuter, Werner (Institut fuer Theoretische Astronomie, Vienna). Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Sitzungsber., Abt. II; 179: No. 8-10, 385-98(1971). (In German).

Assuming certain principles according to Chandrasekhar, the basic analytical formulations and properties of which have been extensively developed in Part I, some numerical results concerning relaxation times, evaporation times and quasi-steady distributions of the star velocities are presented mainly with respect to galactic cluster models. The derived evaporation times are in fair agreement with the "observed" age distribution of real open star clusters and with those determined by numerical experiments on the gravitational n-body problem. For systems containing stars of equal masses, the quasi-steady velocity distribution is very close to the Maxwellian. Yet, no equipartition of energy over the different masses was found in a model with a realistic mass spectrum. (auth)

28886 RADIO FLARE ON β PERSEI. Hughes, V. A.; Woodsworth, A. (Queens Univ., Kingston, Ont.). Nature (London) Phys. Sci.; 236: No. 64, 42-3(20 Mar 1972).

It is stated that, apart from the observation of radio flares from M-type red-dwarf stars, only four stars, all binary systems, have been detected at radio wavelengths, and of these β Persei seemed to be of particular interest following a report that it had been observed to undergo violent flare activity at radio wavelengths. The results of observations at 2.8 cm are reported using the 46-m telescope at the Algonquin Radio Observatory during the period of the flare on Jan 21–22, 1972. These results are combined with those of other observers at 3.7 and 11.1 cm. Details are given of the experimental technique, which employed a beam-switching technique. Flux densities are tabulated. The radiation produced by the flare appeared to have an origin in a nonthermal mechanism and is assumed to be the result of synchroton radiation. There was an interesting similarity between the spectrum of the flare and the spectrum of Cygnus X-1. (UK)

28887 RADIO VARIATIONS OF β PERSEI AND β LYRAE. Hjellming, R. M.; Wade, C. M.; Webster, E. (National Radio Astronomy Observatory, Green Bank, W. Va.). Nature (London) Phys. Sci.; 236: No. 64, 43-6(20 Mar 1972).

The authors recently reported (Nature, 235: 270(1972)) detection of radio emission from the eclipsing binary stars β Persei and β Lyrae; no variation from β Lyrae was detected during these observations, but the radiation of β Persei was clearly variable, with flux densities up to 0.019 f.u. at 8,085 MHz. Further observations of these stars are now reported, between Jan 11 and Feb 16, 1972, using the NRAO interferometer. Simultaneous frequencies of 2,695 and 8,085 MHz were employed, at element spacings of 900, 1,800, and 2,700 m. During this period β Persei behaved very differently from that previously observed, its flux density at 8,085 MHz varying between 0.01 and 0.34 f.u. with a typical time scale of a few hours. The β-Lyrae system faded to a level below detection of the instrument, proving that it also is a variable radio source. Flux densities of β Persei are shown tabulated in detail, and from the data an upper limit of 0.5 arc s was placed on the angular diameter of this source. There was no evident correlation between the radio emission and the light curves. Details are given of the spectral index. It is stated to be difficult to account satisfactorily for the behavior of the radio emission of β Persei by any of the mechanisms usually invoked for celestial radio sources. Flux densities for β Lyrae are also shown tabulated for the period Jan 15 to 24, 1972, and indicate a clear variability over a considerable range, but the data for this star are not considered extensive enough to warrant discussion at present. (UK)

28888 REMARKS ABOUT X-RAYS FROM ETA CARINAE. Davidson, K.; Ostriker, J. P. (Princeton Univ., N. J.). Nature (London) Phys. Sci.; 236: No. 64, 46-8(20 Mar 1972).

Eta Carinae is perhaps the most luminous (10^{40} erg/s) "star" known in the Galaxy, and the two classes of models current for this object are discussed. According to one model this object is a very massive star that ejected a fraction of a solar mass in a major outburst observed during the mid-nineteenth century. The ejecta become visually opaque as dust grains, reradiating the absorbed stellar radiation in the infrared, and the visual emission line spectrum is supposed to come from photoionized gas within the dust shell. The other type of model proposes a very massive and slow supernova remnant at present receiving energy from a central pulsar, in which case much of the observed infrared radiation is nonthermal. In either model the expanding shell produces shock-heated gas as it pushes against the surrounding medium. If this hot gas is sufficiently dense it will emit an observable thermal spectrum, providing a likely explanation for the soft x-ray flux recently observed. The purpose of the present communication is to show that the soft x rays appear to indicate a surprisingly high density for the ambient gas around eta Carinae, and that some useful constraints on models for this object may result from x-ray observations; also that the most sensitive discrimination between models should come from infrared studies. (UK)

28889 NATURE OF THE SECONDARY COMPONENT OF BETA LYRAE. Stothers, R. (Goddard Inst. for Space Studies, New York). Nature (London); 236: No. 5344, 218-19(31 Mar 1972).

ε Aur and β Lyr are among binary systems suggested as possibly harboring a "black hole" as a secondary. Both systems consist of a luminous massive primary and a faint or invisible secondary, whose presence is revealed mainly by the eclipse it produces. From the mass function the secondary must be fairly massive, and is probably in the form of a disk or ring containing an underluminous star, suggested as being a collapsar. In the case of β Lyr, at least, an alternative hypothesis regarding the nature of the secondary star appears possible, and it is suggested that it may be a massive "main-sequence" star in rapid nonuniform rotation. Two other examples of stars whose underluminosity is probably due to high angular momentum are known, and these are sufficiently normal not to be regarded as harboring a "black hole;" these stars are μ' Sco and V 356 Sgr. From the discussion presented it is suggested that before the inference of a collapsar in β Lyr and similar systems can be made plausible the more likely explanation of differential rotation should be investigated more fully. In particular, it would be valuable to investigate theoretically the maximum amount of underluminosity for a model of the β Lyr secondary compatible with dynamic stability and with the requirement that the equatorial radius does not exceed the size of the Roche lobe. (UK)

28890 LIGHT CURVE OF RU CAM FROM 1969.8 TO 1970.6 AND THE VARIATION OF ITS PERIOD. Broglia, P.; Guerrero, G. (Milan-Merate Astronomical Observatory). Astron. Astrophys.; 18: No. 2, 201-8(May 1972).

Two color photoelectric light curves of RU Cam for the interval October 1969 to August 1970 are presented. The period has decreased relative to the value of the previous year and was still changing when the present measurements were made. The residuals of the epochs of maximum and minimum of the years 1962–70 change abruptly from a linear to an oscillatory trend at the end of 1965, about a year after the quasi cancellation of the light pulsation. The oscillation of the O–C is almost sinusoidal, but with a nonconstant period. An analysis of the light curves confirms that an erratic component is superimposed on the periodic one. The substantially constant mean luminosity and color of the variable support the hypothesis of Wallerstein on why the light pulsation ceased. (auth)

28891 MAGNETIC PROPERTIES OF A DEGENERATE ELECTRON GAS AND IMPLICATIONS FOR METALS, WHITE DWARFS, AND NEUTRON STARS. O'Connell, R. F.; Roussel, K. M. (Louisiana State Univ., Baton Rouge). Astron. Astrophys.; 18: No. 2, 198-200(May 1972).

In previous work the absolute stability of the Landau Orbital Ferromagnetic states for both a nonrelativistic and a relativistic electron gas at T = 0 was considered. This work was extended to include the effects of (a) nonzero temperatures, (b) Coulomb interactions, and (c) effective mass values other than unity. As

before, it was concluded that the nonmagnetic (B = 0) state rather than the magnetic Landau Orbital Ferromagnetic states forms the thermodynamically most stable state in thermal equilibrium. Thus, these Landau Orbital Ferromagnetic states are observable only as possible metastable states in metals, white dwarfs, and neutron stars, which could account for the occurrence of large magnetic fields in some white dwarfs but not others. (auth)

28892 THEORETICAL EVOLUTION OF 15 $M_\odot$ AND 11 $M_\odot$ STARS FROM THE MAIN SEQUENCE TO THE He-EXHAUSTION PHASE. Barbaro, G.; Chiosi, C.; Nobili, L. (Univ., Padua). Astron. Astrophys.; 18: No. 2, 186-97(May 1972).

The evolution of 15- and 11-$M_\odot$ stars of extreme Population I (X = 0.602, Z = 0.044) from the main sequence to the helium-exhaustion phase was studied. Both stars were analyzed by taking as the criterion for neutrality in the intermediate convective regions the Schwarzschild–Härm condition $\nabla_r = \nabla_{ad}$. The He-burning phase is different in the two types of star: the 15-$M_\odot$ star in fact begins its He-burning phase as a blue supergiant, then evolves towards the red supergiant region with a nuclear time scale. The 11 $M_\odot$ star, on the contrary, begins the He-burning phase as red supergiant, makes a loop in the HR diagram and then moves again towards the low-effective-temperature region. (auth)

28893 SPALLATION PROCESSES IN STELLAR SURFACES: ANOMALOUS HELIUM RATIOS. Vauclair, S. (Institut d'Astrophysique, Paris. Inst. of Theoretical Astronomy, Cambridge, Eng.); Reeves, H. Astron. Astrophys.; 18: No. 2, 215-23(May 1972).

The evidence regarding spallation processes in stellar surfaces is reviewed. The spallation origin of the $^3He/^4He$ ratio in 3 Centauri A is studied in view of its implications on various physical parameters. The hypothesis can be retained if some (not unduly realistic) conditions are met. The mean bombarding particle energy must be larger than a few MeV, preferably a few hundred MeV. The surface layers should be rather stable (no deep convective zone) and irradiation should (for optimal conditions) have started more than 3×10^4 and less than 3×10^6 years ago. In these conditions the abundance determinations of D (upper limit), ^3He, ^4He can be accounted for, and energy requirements are kept at a reasonably low level (the "particle luminosity" is less than 10^{-4} of the optical luminosity). (auth)

28894 SECULAR STABILITY OF A 1.1 $M_\odot$ STAR DURING THE GRAVITATIONAL CONTRACTION AND THE MAIN-SEQUENCE PHASE. Gabriel, M. (Univ., Liege). Astron. Astrophys.; 18: No. 2, 242-52(May 1972).

The meaning of the secular stability problem is discussed especially for quasi-static models. The problem is applied to a 1.1-$M_\odot$ star during the gravitational contraction and the main-sequence phases. It is found that: (a) the star is unstable during the Henyey's phases (mainly radiative) of gravitational contraction until ignition of the nuclear reactions; (b) the existence of complex roots is connected with the presence of nuclear reactions. (auth)

28895 ORBITAL ELEMENTS OF SPECTROSCOPIC BINARY HD 95363. Imbert, M. (Observatoire, Marseille). Astron. Astrophys.; 18: No. 2, 267-70(May 1972). (In French).

The orbital elements of the spectroscopic binary HD 95363 were obtained from 19 observations. The orbital parameters were computed, from measurements to the final elements, with four FORTRAN IV programs by means of an IBM 1130 computer. (W.D.M.)

28896 PHOTOMETRY OF BRIGHT STARS IN THE LARGE MAGELLANIC CLOUD. Dachs, J. (Ruhr-Univ., Bochum, Ger.). Astron. Astrophys.; 18: No. 2, 271-86(May 1972).

Photoelectric photometry in the UBV system down to a limiting visual magnitude of 14.9m is presented for 68 stars in two fields in the northern part of the Large Magellanic Cloud (LMC). The first field is located around the triple association NGC 1871/1869/1873, the second one in the surroundings of the stellar aggregate NGC 2034. (W.D.M.)

28897 MASS LOSS FROM BINARY COMPONENTS WITH CONVECTIVE OUTER LAYERS. Lauterborn, D. (Univ. of Colorado, Boulder); Weigert, A. Astron. Astrophys.; 18: No. 2, 294-300 (May 1972).

Shell-source-burning stars with deep outer convective layers are shown to expand as a reaction to rapid mass loss. Binary components of this type must start mass exchange on a time scale short compared with the thermal time scale. Using a simple analytical model for the envelope, the numerical results can be understood as due to the conditions for the photosphere, for the shell source, and for the entropy of convective layers. (auth)

28898 METALLIC ABSORPTION LINES OF NOVA DELPHINI BEFORE THE DECEMBER 1967 MAXIMUM. Friedjung, M.; Malakpur, I. (Institut d'Astrophysique, Paris). Astron. Astrophys.; 18: No. 2, 310-17(May 1972).

The profiles of metallic absorption lines of nova Delphini were studied for three dates. The results gave excitation temperatures, and suggested that electron scattering was important in the formation of the profiles. (auth)

28899 CONVECTIVE ENVELOPES AND RADIAL PULSATION OF MASSIVE RED SUPERGIANTS. Stothers, R. (Goddard Inst. for Space Studies, New York). Astron. Astrophys.; 18: No. 2, 325-8(May 1972).

A grid of convective-envelope models covering a wide range of astrophysical parameters (including mass loss) was constructed for M-type supergiants with the help of theoretical evolutionary tracks, mixing-length theory, and the inclusion of hydrogen and helium ionization zones. Linear adiabatic pulsation theory was used to obtain the first four normal modes of radial pulsation for all the models. For the fundamental mode, the quantity $W = P(M/M_\odot)\ (R/R_\odot)^{-2}$ was found to be more nearly constant than is the usual quantity $Q = P(M/M_\odot)^{\frac{1}{2}}\ (R/R_\odot)^{-\frac{3}{2}}$, although the overtone Q values were practically constant. All the convective envelopes were found to be dynamically stable. The theoretical pulsation calculations confirmed that the primary observed period in variable M-type supergiants is probably due to the fundamental mode of radial pulsation and that the long secondary period is not due to a normal mode of radial pulsation. (auth)

28900 INVESTIGATION OF FIELD STARS NEAR NGC 2168 (M 35). Cudworth, Kyle, M. (Univ. of California, Santa Curz). Astron. Astrophys.; 18: No. 2, 318-24(May 1972).

The field stars which were measured in a previous study of the open cluster NGC 2168 were investigated with regard to their secular parallaxes and their luminosity function. The main-sequence stars were segregated by means of proper motion dispersions and approximate distances were determined for these objects, including a correction for interstellar extinction. The motion of NGC 2168 relative to "stars of zero parallax" was determined. The proper motions imply that the appropriate antapex for this low-latitude field probably lies north and west of the standard antapex. The luminosity function appears to be close to normal out to 1 kpc and may be deficient in luminous stars (M_B = 0, +1) beyond that point. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

28901 (AD–720895) X-RAY SPECTROMETRY OF GALACTIC SOURCES SEEN FROM THE SOUTHERN HEMISPHERE. Bosch, Haracio E. (Instituto de Investigaciones Aeronauticas y Espaciales, Buenos Aires (Argentina). Laboratorio de Radiaciones). 10 Mar 1971. 4p. (AFOSR-TR-71-726). NTIS.

The main subject of the investigation performed was the study of the galactic x-ray sources seen from the southern hemisphere. As a byproduct, the detection of soft x rays following the electron-capture decay of radioactive sources was studied. The investigation on galactic x rays was centered in one experiment carried out in Argentina in November 26, 1969. A balloon-borne equipment was launched in order to detect the x rays from the Centaurus XR-4 source. (auth) (USGRDR)

28902 METHOD AND EQUIPMENT FOR THE STUDY OF QUASARS IN MILLIMETER WAVE-LENGTHS. Apushkinskii, G. P.; Vitkovskii, V. V. Uch. Zap. Leningrad. Gos. Univ., No. 359, Ser. Mat. Nauk; No. 47, 46-51(1971). (In Russian).

Harmonic analysis of the flux variations of quasars is discussed. The possibilities of the method are illustrated. The receiver for observations at millimeter wavelengths is described. (auth)

28903 NUMERICAL STUDY OF FLUID FLOW IN A KERR SPACE. Wilson, James R. (Univ. of California, Livermore). Astrophys. J.; 173: No. 2, 431-8(15 Apr 1972).

The equation of motion of a perfect gas is solved on a computer for several cases of matter falling into a Kerr black hole. In most cases, the gas falls into the hole with no appreciable heating. When the material falling in is corotating with the metric, shock waves are formed if the specific angular momentum of the hole is close to 1 and if the specific angular momentum of the infalling material is greater than 2. (auth)

28904 GALAXY NUCLEI AND QUASARS AS INFRARED EMISSION SOURCES. Bisnovatyi-Kogan, G. S.; Syunyaev, R. A.

(Inst. of Applied Mathematics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 697-707(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 881-93(Sep-Oct 1971).

In the event of critical accretion by a neutron star, the density of the incident material at the stellar surface will be such that the Langmuir frequency would agree with the frequency of the infrared peak recently discovered in the spectra of galaxy nuclei. A model for galaxy nuclei and quasars is discussed, comprising a disk of stars with frequent supernova outbursts and a large population of neutron stars. The high gas density in the interstellar space would ensure critical accretion by the neutron stars. Most of the energy released through accretion would be radiated at the plasma frequency, which would differ only slightly for neutron stars of differing mass, and thereby also for different galaxy nuclei. The possible release of energy through accretion of gas by a collapsed star is discussed. (auth)

28905 ALIGNMENT OF PARTICLE SPINS IN QUASAR ENVELOPES. Varshalovich, D. A.; Komberg, B. V. (Technical Physics Inst., Moscow. Inst. of Applied Mathematics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 858-60(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 1085-7(Sep-Oct 1971).

The strong influx of directed radiation in the envelopes of quasars should tend to align the spins of the atoms and ions. The alignment would induce a linear polarization in the wings of the absorption lines as well as anomalous intensity ratios for the lines in multiplets. If quasar spectra were found to exhibit these properties, further evidence would be gained that the absorption lines are formed not in gas clouds remote from a quasar, but in its immediate neighborhood (in an envelope). The physical conditions in the envelope could also be established, in particular, the direction of the regular magnetic-field component and the degree of spin alignment, which characterizes the relative contributions of radiative pumping and collisions in populating the levels. (auth)

28906 REDSHIFT: A DIFFERENT MECHANISM. Urbanovich, S. I. (Inst. of Physics, Minsk). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 756-9(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 957-61(Sep-Oct 1971).

A possible model is proposed for describing the redshift, or an enhanced (diminished) redshift, and, in general, the broadening of spectral lines. The model rests on the assumption that the emitting (absorbing) atoms are subject to some external influence. (auth)

28907 ELECTRON GAS IN SUPERSTRONG MAGNETIC FIELDS: WIGNER TRANSITION. Kaplan, J. I.; Glasser, M. L. (Battelle Memorial Inst., Columbus, Ohio). Phys. Rev. Lett.; 28: No. 16, 1077-9(17 Apr 1972).

It is suggested that in extreme magnetic fields ($H > 10^{12}$ G) a high-density electron gas (in a uniform positive background) undergoes a transition to an ordered structure. This corresponds to the "Wigner" transition of a low-density gas in the absence of a field. It is proposed that the ordered structure is a two-dimensional hexagonal lattice of "charged rods." The lattice spacing is evaluated for densities of astrophysical interest relevant to white dwarfs and pulsars. (auth)

28908 NONMEASURABILITY OF THE LEPTON NUMBER OF A BLACK HOLE. Teitelboim, C. (Princeton Univ., N. J.). Lett. Nuovo Cim.; 3: No. 10, 397-400(4 Mar 1972).

There is a wide class of experiments that could, in principle, be used to determine properties of a black hole, namely scattering experiments. The idea is to calculate the cross section for the scattering of neutrinos by a lepton source located at $r = a$ in a Schwarzschild background and then see if this cross section reduces to the one for scattering of neutrinos by the gravitational field alone, in the limit $a \to 2m$. It is concluded that even though the neutrino field does not decouple from the source in the limit $a \to 2m$, it is still not possible to determine the lepton number of a black hole by means of weakly interacting neutrinos. (W.D.M.)

28909 PULSAR SPEEDUPS RELATED TO METASTABILITY OF THE SUPERFLUID NEUTRON-STAR CORE. Packard, Richard E. (Univ. of California, Berkeley). Phys. Rev. Lett.; 28: No. 16, 1080-2(17 Apr 1972).

The sudden speed changes observed in the Vela and Crab pulsars may be caused by transitions between metastable flow states in the superfluid interior of the star. (auth)

28910 HARD X-RAYS FROM COMA CONSTELLATION. Manchanda, R. K. (Tata Inst. of Fundamental Research, Bombay). Nature (London) Phys. Sci.; 236: No. 65, 51-3(27 Mar 1972).

The region of the sky defined by RA = 190° to 330° and $\delta = -20°$ to +50° was scanned for high energy x-ray sources in a series of balloon flights from Hyderabad made since April 1968, using oriented x-ray telescopes, and the sky map of hard x-ray intensity in the energy range 20 to 150 keV is shown. Clustering in the regions of known sources such as Sco X-1, Cyg X-1, and GX 9 + 9 is clearly evident. Two other regions also show significant clustering; the first falls in the Virgo constellation and details have been given elsewhere, while the second falls in the Coma constellation and is the primary concern of this communication. Plots of counting rates for the latter are shown, and a marked radiation excess was recorded from the region RA = 200° to 215° and $\delta = 25°$ to 50°. Spectral information is shown graphically. The data suggest that there may be more than one discrete source in this part of the sky, and studies with better angular resolution are needed; also information on low-energy spectral characteristics. (UK)

28911 SIMULTANEOUS HARD X-RAY AND OPTICAL OBSERVATIONS OF SCO X-1. Matsuoka, M. (Tokyo Univ. Nagoya Univ., Japan. Tata Inst. of Fundamental Research, Bombay. Univ. of Osmania, Hyderabad, India). Nature (London) Phys. Sci.; 236: No. 65, 53-5(27 Mar 1972).

It is stated that correlation between the x-ray and the optical emissions of Sco X-1 may provide an important clue in the understanding of the properties of this "peculiar" object. Previous observers have reported contradictory results concerning this correlation. In the study described simultaneous observations of hard x-ray and optical emissions were made at Hyderabad. The x-ray detector consisted of a pair of NaI(Tl) scintillation counters, calibrated in flight by a ^{241}Am source, and balloon carried. The difference between the counting rate while one of the counters was pointing at Sco X-1 and the average of the counting rates measured in two adjacent intervals, while the counter was pointing in the opposite direction, was attributed to Sco X-1. Energy spectra are shown graphically, and are discussed. At the same time as the balloon flight Sco X-1 was observed photographically with an 8 in. astrograph. The following three conclusions can be deduced from the data obtained. Firstly, there is a positive correlation between thermal x-ray and optical emissions, the correlation coefficient being ~0.7. Secondly, nonthermal x-rays are emitted in association with optical flares. Thirdly, the spectrum of x rays with energies 25 to 40 keV is represented by a thermal bremsstrahlung spectrum, in agreement with earlier findings. (UK)

28912 SECOND SPEED-UP OF THE CRAB PULSAR. Lohsen, E. (Hamburger Sternwarte, Hamburg). Nature (London) Phys. Sci.; 236: No. 66, 70-1(3 Apr 1972).

It is stated that optical timing of the Crab pulsar revealed a speedup of 0.0046 periods per day on Oct 26, 1971. This speedup was apparently not a single sudden event, and appeared to be similar to the large speedup observed in Sept 1969. The data suggest that the speedup took place in at least two stages within three days, and may even have been almost continuous. Changes in parameters during the speedup are shown tabulated. Estimation of the time of a future speedup may be possible. Arrival times of optical pulses from the Crab pulsar are at present being measured at the 60-cm refractor of the Hamburg Observatory. (UK)

28913 STUDY OF GALACTIC SUPERNOVA REMNANTS. I. DISTANCES, RADIO LUMINOSITY FUNCTION, AND GALACTIC DISTRIBUTION. Ilovaisky, Sergio A.; Lequeux, James (CEN, Saclay. Observatoire de Paris, Meudon, France). Astron. Astrophys.; 18: No. 2, 169-85(May 1972).

Recent radio-frequency absorption-line observations for supernova remnants (SNR) are used to derive kinematic distances for twenty sources. The relation between radio surface brightness, Σ, and linear diameter, D, is confirmed and recalibrated $\Sigma \sim D^{-4.0\pm0.2}$. Using the improved distance scale and the data presented in various published SNR catalogues distances are derived for approximately one hundred SNR. The radio luminosity function for SNR is studied in detail through integral number–diameter diagrams. Limiting-flux selection effects are quantitatively discussed and corrected for. Using SNR within 6.3 kpc of the Sun an integral luminosity function of the type n (<D) $\sim D^{-2.40\pm0.60}$ for D < 30 pc is derived. For D > 30 pc a new selection effect (probably a limiting-surface brightness effect) is shown to exist for large-diameter SNR which effectively reduces the number of such objects detected in radio surveys. A comparison of observations with theoretical luminosity functions is made which leads one to conclude that isothermal expansion of SNR probably does not become effective for D < 30 pc. No choice can be made between adiabatic or cosmic ray-driven models. The galactic distribution of SNR is derived in distance from the galactic center and in height from the galactic plane. The radial distribution of the surface density of SNR can be approximated by a constant function with a sharp cut-off at 10 kpc from the galactic center. The distribution perpendicular to the galactic plane is shown to be much thinner for SNR in the inner regions of the Galaxy than for SNR in the outer regions. The neutral hydrogen disk exhibits

a similar behavior. From this it is concluded that SNR are distributed in a flat disk of 10 kpc radius whose thickness increases with distance from the center. The mean z-distribution within 6 kpc from the Sun can be approximated by $n(z) \sim n(0) \exp(-|z|/90$ pc). Comparing the z-distributions for SNR and extreme Population I objects it is found that the thickness of the SNR distribution is identical, within the uncertainties, to that of the youngest (O and B) stars and slightly thinner than that of Cepheids. This is taken to indicate that most supernovae belong to extreme Population I. (auth)

28914 SURVEY OF POSITIVE VELOCITY NEUTRAL HYDROGEN ABOVE THE GALACTIC PLANE BETWEEN l = 252° and l = 322°. Wannier, P. (Princeton Univ., N. J.); Wrixon, G. T.; Wilson, R. W. Astron. Astrophys.; 18: No. 2, 224-31(May 1972).

A survey is presented of positive velocity hydrogen in the range +18 to +334 km/s occupying the region of the sky between l = 252° and 322° and b = +10° and +30° (approximately). A number of high-velocity features discovered by other observers are seen as are several others previously undetected high-velocity complexes. The possibility is discussed that these are high-latitude extensions of spiral arms lying far outside our own arm. A search for high-velocity hydrogen at $+300 < v < +600$ km/s on a 5° grid over this region produced negative results. (auth)

28915 ORIGIN OF QSOs. Terrell, J. (Los Alamos Scientific Lab., Albuquerque, N. Mex.). Nature (London); 236: No. 5343. 166(24 Mar 1972).

Reference is made to Nature, 234: 172(1971) where the opinion was expressed that the lack of observed blue shifts for quasars essentially rules out local origin. The present author states that although this may be a valid objection to some forms of local theory, it is not so for the "very local" theory according to which quasars were ejected a few million years ago from the center of the Galaxy, the nearest being only a few hundred thousand light years away, and such a distance is consistent with the observed upper limits on proper motion. On this basis local quasars would have only redshifts. An attractive feature of this theory is that it can even account for radio galaxies in terms of the ejection of clouds of quasars from gravitationally collapsing galactic centers. It is considered that the "very local" quasar theory deserves more attention, especially in connection with recent discoveries of very rapid relative motion of radio sources associated with several quasars. (UK)

28916 MODEL OF CYGNUS X-1. Jackson, J. C. (Royal Greenwich Observatory, Herstmonceux, Eng.). Nature (London) Phys. Sci.; 236: No. 64, 39-41(20 Mar 1972).

The hard x rays from Cygnus X-1 are attributed to inverse Compton scattering of ultraviolet photons from the B star known to be one component of the source. The other component is assumed to be the source of relativistic electrons. This provides a natural explanation of the "anti-eclipse" feature of the x-ray variability. The electrons should also produce synchrotron radiation in the infrared. The predicted flux density at 100 μm is about 10^{-23} W m^{-2} Hz^{-1}. (auth)

28917 PROBLEM OF PULSAR DISTANCES. Cavallo, G.; Ventura, A. (Space Research Group, Bologna). Astron. Astrophys.; 18: No. 3, 287-93(May 1972).

The justifications for a period–luminosity function for pulsars are examined in detail, and consequences are discussed. Distances to pulsars are derived and these new estimates are compared with recent work on the subject, based on the dispersion measure (DM). It appears that most of the DM is due to dense discrete H II clouds (mostly Strömgren spheres belonging to high-temperature stars). (auth)

28918 OBSERVATIONS OF THE 21-cm HYDROGEN-EMISSION LINE IN THE DIRECTION OF 25 PULSARS. Sancisi, R.; Klomp, M. (Kapteyn Astronomical Lab., Groningen, Netherlands). Astron. Astrophys.; 18: No. 2, 329-34(May 1972).

The 25-m Dwingeloo radio telescope was used to obtain 21-cm emission-line profiles in the direction of 25 pulsars. An atlas of the profiles and a table of hydrogen column densities are given. (auth)

Solar Phenomena

Refer also to abstracts 29010–29017, 29021, 29023, 29024, and 29050.

28919 (AD–732792) RADIATION AND RELATED PROCESSES IN PLASMAS. Status Report No. 1. Sturrock, P. A.; Fung, P. C. W.; Newman, C. E.; Epstein, R. I. (Stanford Univ., Calif. Inst. for Plasma Research). Nov 1971. Contract N00014-67-A-0112-0062. 11p. NTIS.

Radiation and related processes in plasmas are discussed, including single-particle and collective emission processes and the reaction of these processes on the particle distribution function to produce acceleration and diffusion. The principal objective is the study of radiation processes occurring in geophysical, interplanetary, and astrophysical plasmas. A secondary objective is the study of various mathematical approaches that have been proposed for the study of radiation, with the aim of evaluating and comparing these methods. (auth) (NTIS)

28920 (ADP–111) ULTRAVIOLET ION CHAMBER MEASUREMENTS OF THE SOLAR MINIMUM BRIGHTNESS TEMPERATURE. Carver, J. H.; Horton, B. H.; Lockey, G. W. A.; Rofe, Bryan (Adelaide Univ. (Australia). Dept. of Physics). Feb 1972. 12p. Dep. NTIS (U. S. Sales Only).

The solar ultraviolet flux in the wavelength bands 1580 to 1640 Å and 1430 to 1470 Å (FWHM) was measured using photon ion chambers carried on the satellite WRESAT I (1967-118A). These observations of the integrated ultraviolet flux from the entire disk indicated a value of (4570 ± 50)°K for the solar temperature minimum. The results are compared with other estimates of the minimum value of the solar brightness temperature. (auth)

28921 USE OF SOLAR ECLIPSE TIMINGS TO COMPARE THE REFERENCE SYSTEMS OF NEWCOMB'S TABLES OF THE SUN AND OF THE IMPROVED LUNAR EPHEMERIS. Duncombe, R. L.; Haupt, R. F.; Duncombe, J. S. (Naval Observatory, Washington, D. C.). Solar Phys.; 21: No. 2, 260-2(Dec 1971).

Photoelectric, photographic, and visual observations of second and third contacts of the total solar eclipses of November 12, 1966 and March 7, 1970 are analyzed. The observations indicate a difference in the reference system of Newcomb's Tables of the Sun as compared to the reference system of the Improved Lunar Ephemeris (J = 2) of $0^s.911 \pm 0^s.034$ m.e. The correction is to be applied in the sense of reducing the value of ΔT as tabulated in the American Ephemeris when interpolating the position of the Moon. (auth)

28922 CORONAL AND INTERPLANETARY MAGNETIC FIELDS AT THE TIME OF THE SOLAR ECLIPSE OF MARCH 7, 1970. Stenflo, J. O. (High Altitude Observatory, Boulder, Colo.). Solar Phys.; 21: No. 2, 263-71(Dec 1971).

The magnetic field in the outer corona and in interplanetary space was calculated from the photospheric magnetic fields measured around the time of the March 7, 1970 eclipse. The field-line maps were compared with eclipse photographs showing coronal structures out to about 12 $R_\odot$. The projected field lines as well as the observed streamers appeared straight. This was caused by the rapid expansion of the outer corona and is not an indication of corotation. The calculations show that the angular velocity of the coronal plasma decreases rapidly with distance. The relation between magnetic fields and density enhancements is discussed. The field strength in the photosphere seems to determine the amount of mechanical heating of the lower corona. The density structure higher up in the corona will, however, depend decisively on the topology of the field, particularly on whether we are on open or closed field lines, and not simply on field strength. The calculations show a sector structure of the interplanetary field, which agrees well with spacecraft observations. Also the magnitudes of the observed and calculated interplanetary field agree after the Mt. Wilson magnetograph data have been corrected to account for the temperature and saturation effects in the spectral line FeI 5250 Å. (auth)

28923 CORONAL ELECTRON DENSITY MAPS FOR MARCH 7, 1970, DERIVED FROM Mg X λ625 SPECTROHELIOGRAMS. Withbroe, G. L.; Dupree, A. K.; Goldberg, L.; (and others) (Harvard Coll. Observatory, Cambridge, Mass.). Solar Phys.; 21: No. 2, 272-80(Dec 1971).

Daily Mg X λ625 spectroheliograms acquired by the Harvard College Observatory experiment on OSO-6 were analyzed for a 28-day period centered on March 7, 1970, the date of a well-observed total solar eclipse. These data were used to construct maps of the variation across the solar disk of the electron density at the base of the corona. The correspondence of high- and low-density regions with regions of enhanced and reduced emission in white light and Mg X pictures made during or near the time of the eclipse is described. (auth)

28924 SPECTRAL LINES FROM PHOTOSPHERE TO CHROMOSPHERE, OBSERVED DURING THE MARCH 1970 ECLIPSE; A FIRST COMPARISON WITH THEORY. Houtgast, J.; Namba, O.; Rutten, R. J.; Wijbenga, J. W. (Astronomical Inst., Utrecht). Solar Phys.; 21: No. 2, 281-5(Dec 1971).

A brief report is presented on observations of line profile variations in the transition region from the photosphere to the chromosphere, based on high-resolution eclipse spectrograms. Some computations are also shown for several lines whose behavior agrees in general with the observations. (auth)

28925 OBSERVATIONS OF THE MARCH 7, 1970 TOTAL SOLAR ECLIPSE AT WAVELENGTHS OF 3.2 AND 8.3 mm. Hagen, John P.; Swanson, Paul N.; Haas, Robert W.; Wefer, Fred L.; Vogt, Raymond W. (Pennsylvania State Univ., University Park). Solar Phys.; 21: No. 2, 286-96(Dec 1971).

The March 7, 1970 total solar eclipse was observed at wavelengths of 3.2 and 8.3 mm; the object being to use the knife edge of the Moon as it passed across the Sun to improve angular resolution on the Sun. This in turn would provide a radial brightness distribution of the Sun with an angular resolution of a few seconds of arc. Excellent eclipse curves were obtained at 3 mm; however, some external interference marred the 8 mm record near totality. The 8 mm brightness distribution is subject to some uncertainty, but tends to show limb brightening. The 3 mm brightness distribution shows a well defined complex limb brightening within about 1 arc min of the optical limb. The maximum brightening is approximately 30% above the average disc temperature. (auth)

28926 HIGH-RESOLUTION OBSERVATIONS OF THE CHROMOSPHERE AT mm AND cm WAVELENGTHS. Simon, M. (State Univ. of New York, Stony Brook). Solar Phys.; 21: No. 2, 297-304(Dec 1971).

High-resolution observations of the Sun at 3.3 mm, 3.5 mm, 1.35 cm, and 1.95 cm, obtained by tracking narrow-beamwidth antennas on the lunar limb as it occulted the Sun, are described. The observations indicate that: (1) the region emitting at these wavelengths is very irregular with typical length scales smaller than one half minute of arc, (2) the number of roughness elements responsible for the irregular structure is small within an area of one half minute of arc square, and (3) the roughness elements observed at wavelengths greater than 1 cm extend to 10^9 cm beyond the optical limb. (auth)

28927 FINE STRUCTURE IN THE INNER CORONA OBSERVED AT THE 1970 ECLIPSE. Tsubaki, T. (Univ. of Shiga, Ohtsu, Japan); Kurokawa, H.; Kanno, M. Solar Phys.; 21: No. 2, 305-13(Dec 1971).

On the slit spectrogram obtained at the 1970 eclipse in Mexico, the intensities of four coronal lines (Ni XIII λ5116, Fe XIV λ5303, Fe X λ6374, and Ni XV λ6702) and the continuum were measured as a function of distance along the slit. It was found that a lot of fine fluctuations exist, both in the lines and in the continuum intensities superposed on a large-scale formation. The correspondence of such fluctuations between the continuum and the lines is good, with the exception of the line λ6374 which shows a peculiar fluctuation. It is shown that the intensities of the three lines λλ5116, 5303, and 6702 seem to be proportional to the square of the continuum intensity, while the λ6374 line intensity may be proportional to the fourth power or more. (auth)

28928 PHYSICAL CONDITIONS IN INNER CORONA DERIVED FROM SPECTRAL DATA OF THE SOLAR ECLIPSE ON MARCH 7, 1970. Gurtovenko, E. A.; Alikaeva, K. V. (Main Astronomical Observatory, Kiev). Solar Phys.; 21: No. 2, 325-31(Dec 1971).

The spectrum of the solar corona obtained during the eclipse of March 7, 1970 was studied. From the analysis of the line halfwidths it was concluded that the emission of coronal lines of various groups arises in different volumes of the corona. The lines λ5303 and λ4231 were analyzed in detail and by the use of the equations of excitation and ionization balance. The distribution of electron temperature T_e and density n_e vs height in the solar corona was found. The usually adopted n_e and T_e were noticeably less than those values obtained in present analysis. This discrepancy may be due to the fact that the considered area of the corona seems to be in an unusual condition. (auth)

28929 SPECTROPHOTOMETRY OF THE CORONA AND A QUIESCENT PROMINENCE BASED ON OBSERVATIONS OF THE TOTAL SOLAR ECLIPSE OF MARCH 7, 1970 IN MEXICO. Nikolskii, G. M.; Gulyaev, R. A.; Nikolskaya, K. I. (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Moscow). Solar Phys.; 21: No. 2, 332-50(Dec 1971).

Slit spectrograms of a quiescent prominence and the inner corona ($h \leq 2.5$ arc min) in the range λλ3400 to 7000 Å (dispersion 6 to 10 Å/mm) were obtained. From an analysis of the Stark effect on the Balmer lines (up to number 36) the electron density in the prominence $n_e = (7 \pm 3) \times 10^{10}$ cm^{-3} was deduced. The kinetic temperature T_k and the nonthermal velocities v_t, found from a simultaneous consideration of the Balmer and metal lines, are $T_k \approx 10{,}000$ K and $v_t \approx 6$ km/s. Also the emission measure of the prominence along the line-of-sight was found: $ME = 10^{31}$ cm^{-5}. In the coronal spectrum 24 coronal lines were found. Thirteen of these lines were identified and measured photometrically to get their absolute intensities, profiles, and halfwidths. For nine lines the intensities as a function of the height were studied and on this basis the coronal lines were divided into a few groups. The line-of-sight and nonthermal velocities are $v_r \leq 10$ km/s and $v_t \approx 25$ km/s. The coronal lines originate in at least three types of regions with different temperatures. The emission measure as a function of the ionization temperature was determined. The abundances of four elements of the iron group (V, Cr, Mn, Co) were estimated. The abundances of the other elements of the same group (Ar, Ca, Fe, Ni), found from euv data, were in a good agreement with the observations. The degree of inhomogeneity in the corona was estimated: $\overline{n_e^2}/(\overline{n}_e)^2 \approx 3$ to 10. (auth)

28930 OBSERVATIONS OF THE INFRARED Fe XIII LINES IN THE SOLAR CORONA OF NOVEMBER 12, 1966. Byard, Paul L. (Ohio State Univ., Columbus); Kissell, Kenneth E. Solar Phys.; 21: No. 2, 351-9(Dec 1971).

Some intensity measurements of the Fe XIII lines at 10,747 Å and 10,798 Å made during the total eclipse of November 12, 1966 are reported. Infrared spectra were taken of the solar corona at a dispersion of 90 Å per mm, using an RCA image converter and spectrograph aboard the NASA CV 990 aircraft off the coast of southern Brazil. The spectra were reduced to equivalent width in terms of the coronal continuum and values derived for different points in the corona. The observed equivalent widths of the lines were in the range 10 to 30 Å for the 10,747 line and 5 to 12 Å for the 10,798 line. The ratio of these equivalent widths was found to vary from 2.3 in the inner corona to 6 at a point 1.36 solar radii from the center of the Sun. The above results are discussed in terms of the excitation mechanisms involved in producing the lines. In particular, the results are compared with the recent theoretical calculations of Chevalier and Lambert, who were the first to include the effects of proton collisions in the excitation of the $3p^2\ ^3P$ levels of Fe XIII. The observations were consistent with an electron density of 4×10^8 in the inner corona; a value which compares favorably with those derived by other observers from the strength of the K continuum. These were the first eclipse observations of the infrared Fe XIII lines which indicated that proton collisions are important in the excitation of the coronal lines. The coronal abundance of iron was estimated from the equivalent width of the 10,747 line, and an overabundance as compared to the photospheric abundance by a factor of 10 was found. (auth)

28931 SOME NEWLY DISCOVERED CORONAL EMISSION LINES FROM HIGH ALTITUDE INFRARED OBSERVATIONS OF THE MARCH 7, 1970, SOLAR ECLIPSE. Olsen, Kenneth H.; Anderson, Charles R.; Stewart, John N. (Los Alamos Scientific Lab., N. Mex.). Solar Phys.; 21: No. 2, 360-71(Dec 1971).

A survey of the infrared coronal spectrum between 1 and 3 μ was made from a high altitude aircraft during the March 7, 1970, solar eclipse. The observations were made with a Fourier transform spectrometer and were confined to the outer chromosphere and inner corona. In addition to well known chromospheric lines of H I and He I, nine additional lines were seen. Evidence is presented for the tentative assignment of these lines to forbidden transitions in highly ionized atoms of magnesium, aluminum, silicon, sulfur, and chromium. (auth)

28932 ECLIPSE OBSERVATIONS IN THE ROCKET ULTRAVIOLET. Jones, T. L. J. (SRC Astrophysics Research Unit., Culham, Eng.); Parkinson, W. H.; Speer, R. J.; Yang, C. Solar Phys.; 21: No. 2, 372-80(Dec 1971)

An Aerobee 150 was launched into the umbra from Wallops Island at 18:36:15 UT March 7, 1970, carrying two intensity-calibrated euv Wadsworth grating spectrographs. The experiment was a collaborative venture between groups from A.R.U. Culham, H.C.O., Imperial College and York University, Toronto. This was the first attempt to record stigmatic spectra of the chromosphere and corona in the euv, analogous to the visible eclipse Flash Spectrum. A wealth of new observational data has demonstrated the importance of a new instrumental and experimental technique for recording the ultraviolet flash spectrum. Lyman-α limb spectroheliograms reveal complex activity extending high into the corona in contrast to the modest level of activity observed in Hα. Preliminary intensity reduction shows that Lyman-α dominates as the principal radiation loss for these features. (auth)

28933 IDENTIFICATION OF NEW FORBIDDEN CORONAL LINES IN THE SOLAR EUV SPECTRUM. Jordan, Carole (Culham Lab., Abingdon, Eng.). Solar Phys.; 21: No. 2, 381-91(Dec 1971).

Identifications are proposed for twenty of the twenty-eight

coronal lines observed in the spectra obtained during a rocket flight into the path of the March 7, 1970 solar eclipse. The methods by which the lines have been identified are discussed. Most of the lines identified are from forbidden transitions between levels in the ground $2p^n$ and $3p^n$ configurations in high ions of magnesium, silicon, sulfur, iron, and nickel. The temperature range represented is from 6.9×10^5 K to 2.5×10^6 K. The classification of three lines of Fe XII and two of Ni XIV has led to a revised identification for the near-ultraviolet $^2D_{\frac{3}{2}} - ^2P_{\frac{1}{2}}$ transition in Fe XII. This transition can be identified with the line at 3072 Å rather than that at 3021 Å as previously suggested in the literature. (auth)

28934 MEASUREMENTS ON THE LYMAN ALPHA CORONA. Gabriel, A. H. (Culham Lab., Abingdon, Eng.). Solar Phys.; 21: No. 2, 392–400(Dec 1971).

As a result of a collaborative rocket experiment carried out during the solar eclipse on March 7, 1970, measurements were made of the brightness of Lyman α from the corona, at heights between 5×10^4 and 5×10^5 km above the limb. The emission is shown to occur primarily through the resonance scattering of chromospheric Lyman α from the residual neutral hydrogen in the corona. Both the absolute value and radial falloff of the brightness agree well with calculations based on solar density models. The Lyman α emission has similar variations around the limb to the white light corona, showing in particular an equatorial enhancement. (auth)

28935 RELATION BETWEEN THE WHITE LIGHT AND XUV CORONAS ON MARCH 7, 1970. Tousey, R.; Koomen, M. J. (Naval Research Lab., Washington, D. C.). Solar Phys.; 21: No. 2, 401-7(Dec 1971).

The white-light corona from 3 to 9 $R_\odot$ and the xuv (170 to 500 Å) corona, photographed from a rocket at 1930 UT on March 7, 1970, are compared with the x-ray corona photographed from a rocket flown at 1900 UT by AS and E, the H Ly-α corona obtained during totality by Speer et al., the Fe XIV 5303 Å corona from Hawaii, and total-eclipse photographs in white light and infrared. (auth)

28936 ROCKET-CORONAGRAPH PHOTOMETRY OF THE MARCH 7, 1970 CORONA FROM 3 TO 8.5 $R_\odot$. Bohlin, J. D.; Koomen, M. J.; Tousey, R. (Naval Research Lab., Washington, D.C.). Solar Phys.; 21: No. 2, 408-17(Dec 1971).

A rocket-borne coronagraph utilizing external occulting disks was used to photograph the solar corona from 3 to 9 $R_\odot$ at 1931 UT on March 7, 1970. Comparison of the rocket and ground-based observations showed a one-to-one correspondence between major streamers from the inner to the outer corona. In particular streamers over the poles were clearly visible against the background corona from 3 to $\gtrsim 8$ $R_\odot$. These rocket data had a scattered light level of $\sim 1.2 \times 10^{-10}$ $\bar{B}_\odot$. The derived quiet equatorial and polar K + F corona was within 10% of the absolute brightness of standard coronal models and displayed identical radial gradients to those models. The photometric profiles of the NE limb streamer were analyzed assuming a model in which the core density follows a Gaussian distribution in directions perpendicular to the radius vector. This streamer was assumed to be rooted on the visible disk at 55 to 60° from the plane-of-the-sky as based on K-coronameter and xuv data. An uncertainty of as much as a factor of three still remains for the value of the axis density owing to uncertainty in the line-of-sight dimension of the streamer. (auth)

28937 POLARIZATION-COLOR EFFECT IN THE K-CORONA. Billings, Donald E.; Oh, Young (Univ. of Colorado, Boulder). Solar Phys.; 21: No. 2, 418-24(Dec 1971).

An observation of the corona during the March 7, 1970 eclipse through a Wollaston prism-red and blue filter combination was carried out for the purpose of confirming the prediction that the component of the K corona with electric vector radial to the Sun is redder than the tangential component. An analysis of a portion of the resulting data seemed to confirm this prediction and also indicated that the method is useful for determining the three-dimensional configuration of the very inner corona. A three-dimensional configuration is suggested for a portion of the NE quadrant of the Sun, including the large NE streamer and an adjacent low-lying loop. (auth)

28938 RESULTS OF POLARIZATION OBSERVATIONS OF THE OUTER CORONA FROM A JET AIRCRAFT. Keller, C. F. (Los Alamos Scientific Lab., N. Mex.). Solar Phys.; 21: No. 2, 425-9(Dec 1971).

White-light photographs of the solar corona were taken during the March 1970 eclipse from an Air Force NC-135 jet aircraft at an altitude of 36,380 ft. Four photographs each were made for several exposure times varying from 0.1 to 10.0 s. Three each were made with plane polaroid filters whose orientation was varied at 60° intervals. Stabilization of the camera was approximately 10″ even during the longest exposures. The corona was recorded to distances beyond 12 $R_\odot$. A preliminary study of percent polarization as a function of position with respect to the solar disk for a set of 1.0-s exposures shows an inversion in percent polarization in the region 6 to 8 $R_\odot$—polarization decreasing outward to the region and increasing again beyond it. This inversion is most apparent along the major streamers. Intensities traced outward from the Sun in both polar equatorial directions are compared with previous observations. (auth)

28939 PHOTOMETRIC INTENSITY AND POLARIZATION MEASUREMENTS OF THE SOLAR CORONA. McDougal, David S. (Langley Research Center, Hampton, Va.). Solar Phys.; 21: No. 2, 430-8(Dec 1971).

During the March 7, 1970, total eclipse of the Sun, the NASA Langley Research Center's Satellite Photometric Observatory (SPO) was used to measure the solar corona from Miahuatlan, Mexico. The SPO is equipped with a 24-inch Cassegrainian telescope, a four-channel photoelectric photometer, a Wollaston prism, and a rotating half-wave plate. Simultaneous measurements were made of the two orthogonal components of coronal light in the B and R bands of the UBVRI system. A 1-minute arc aperture was scanned from the lunar disk center out to five solar radii in a series of spirals of gradually increasing radius. For the first time, simultaneous multicolor intensity, degree, and angle of polarization profiles are computed from photoelectric measurements. Comparison of the variations of the measurements for each spiral scan yields a detailed picture of the intensity and polarization features in the K corona. (auth)

28940 POLARIZATION OF CORONAL EMISSION LINES. Beckers, J. M. (High Altitude Observatory, Boulder, Colo.); Wagner, W. J. Solar Phys.; 21: No. 2, 439-47(Dec 1971).

By means of a photographic polarimeter, an attempt was made to measure both the amount and direction of linear polarization of all emission lines between 3400 and 9000 Å in the inner corona ($1.034 \leq r/r_\odot \leq 1.085$). Only the green and red coronal lines were analyzed in detail. Neither of these lines showed polarization exceeding the probable error of 1.0% for λ5303 and 1.8% for λ6374. None of the other 17 coronal lines observed during the March 7, 1970 solar eclipse showed any obvious (>5%) polarization. (auth)

28941 INTERFEROMETRIC STUDIES OF SPECTRAL LINES IN THE SOLAR CORONA. Hirschberg, Joseph G.; Wouters, Alain; Hazelton, Lyman Jr. (Univ. of Miami, Coral Gables, Fla.). Solar Phys.; 21: No. 2, 448-51(Dec 1971).

A photographic Fabry–Perot interferometer was used to measure the breadth and wavelength of the Fe XIV spectral line at 5303 Å in the solar corona during the eclipse of March 7, 1970, in Mexico. The observations were consistent with a possible large-scale vortex structure in a bright streamer, in which cooler gases revolved about a hotter core. (auth)

28942 LOCALIZATION OF THE SOURCE OF FLARE X-RAY EMISSION DURING THE ECLIPSE OF MARCH 7, 1970. Kreplin, R. W.; Taylor, R. G. (Naval Research Lab., Washington, D. C.). Solar Phys.; 21: No. 2, 452-9(Dec 1971).

An occultation of x-ray emission from a solar flare occurred during the eclipse of March 7, 1970 and was observed by an NRL instrument aboard the OSO-5 satellite. Ionization chamber photometers covering the wavelength ranges 0.5 to 3 Å, 1 to 8 Å, and 8 to 16 Å provided flux measurements once every 15 s providing a spatial resolution of 20 arc sec at the solar surface. Within this limitation the x-ray flare was observed to be confined within a region 136,000 km in one dimension. However, the measurements indicate the existence of a denser core 54,000 km wide in the direction of advance of the Moon's limb. Comparison of these results with x-ray photographs of flare regions was made, and a model for the development of the soft x-ray flare is proposed. (auth)

28943 ECLIPSE OF RADIO EMISSION ON MARCH 7, 1970 AT 10 cm WAVELENGTH FROM THE ACTIVE REGION ASSOCIATED WITH McMATH PLAGE 10 618. Mayfield, Earle B. (San Fernando Observatory, El Segundo, Calif.); Chapman, Gary A.; Straka, Ronald M. Solar Phys.; 21: No. 2, 460–8 (Dec 1971).

Radio emission of 10 cm from the whole disk was monitored during the eclipse of March 7, 1970 by the Aerospace San Fernando Observatory and AFCRL Sagamore Hill Solar Radio Observatory. For both, the active region associated with sunspot 17 774, McMath region 10 618, was occulted. At Sagamore Hill the entire region was occulted. At SFO only the southern half of the sunspot group and the hydrogen plage southeast of the group were occulted. This region produced an importance class 1N flare and 10 cm burst

beginning at 1601 UT and was enhanced about 15 flux units above the mean value of 190 units at onset. The Sagamore Hill data indicate the region was about 3.8′ and contributed about 0.21 of the total radiation from the disk. The SFO data gave about 5.4′ for the size of the southern half of the region and showed that about 0.20 of the total radiation came from there. Radiation came primarily from the hydrogen plage southeast of the major spot of the group. The hydrogen plage northwest of the group did not contribute significantly. Although the small flare occurred in this region, it did not contribute more than 0.04 of the total (0.20 of the active region) at occultation of region 10 618. (auth)

28944 SPECTRAL RADIO OBSERVATIONS OF A SOLAR ECLIPSE. Straka, R. M. (Air Force Cambridge Research Labs., Bedford, Mass.). Solar Phys.; 21: No. 2, 469-80(Dec 1971).

Measurements were made of the March 7, 1970 solar eclipse by the AFCRL Sagamore Hill Radio Observatory in Hamilton, Massachusetts, on the wavelengths of 0.86, 1.95, 3.4, 6.0, 11.1, 21.2, 49.5, and 122.5 cm. Near-total obscuration (m = 0.96) occurred at eclipse maximum. Source flux spectra for the intense sources located in McMath plages 10 618(SE), 10 617(NE), and 10 607(NW) showed gyro-resonance spectral peaking, whereas the less-intense bremsstrahlung emission was observed for the weaker sources in plages 10 614 and 10 619. Associated one-dimensional source sizes for these regions varied from 0.8 arc min (at 3.4 cm) to 5.4 arc min (at 49.5 cm); with sizes at a particular wavelength increasing with intensity of the source. An estimated flux spectrum of the undisturbed radio Sun for March 7, 1970 is given and compared to the spectrum for the solar minimum of 1964. In plage 10 607 a weak halo emission was isolated from the intense emission from the central source over the spot. The measure of emission $\bar{N}^2L$ from the halo above plage 10 607 was calculated to be $\approx 7 \times 10^{27}$ electron^2/cm^5. (auth)

28945 XUV IMAGE OF THE SUN FROM ECLIPSE OBSERVATIONS OF THE IONOSPHERIC E REGION. Marriott, R. T.; St. John, D. E.; Thorne, R. M.; Venkateswaran, S. V. (Univ. of California, Los Angeles). Solar Phys.; 21: No. 2, 483-94(Dec 1971).

Ionospheric E-region observations from Boulder, Grand Bahama, Mexico City, Vandenberg, and Wallops Island during the total solar eclipse of March 7, 1970 were used for reconstructing the distribution of the ionizing xuv radiation over the solar disk. The derived solar image compares reasonably well with the euv and x-ray pictures of the Sun obtained from rockets. (auth)

28946 PHOTOIONIZATION OF POSITIVE IONS OF ATOMIC OXYGEN. Missavage, D. W.; Manson, S. T. (Georgia State Univ., Atlanta). Phys. Lett.; 38A: No. 2, 85-6(17 Jan 1972).

The photoionization cross section of the K-shell of atomic oxygen and its positive ions to O^{6+} was calculated using Hartree–Slater wave functions and compared with hydrogen-like results. The implications for other shells and other atoms are discussed. (auth)

28947 CORONAL LINES IN THE CHROMOSPHERE AT THE 1970 ECLIPSE. Kanno, M. (Kyoto Univ.); Tsubaki, T.; Kurokawa, H. Solar Phys.; 21: No. 2, 314-24(Dec 1971).

Spectrographic observations of the flash spectrum were made by the Kwasan Observatory at the total solar eclipse on March 7, 1970. The integrated intensities of Fe XIV λ5303, Fe X λ6374, and the continuum were measured on the spectrograms as a function of height above the Sun's limb. It was found that a large amount of emission in the coronal lines originates in the interspicular regions of the chromosphere. Analysis of the data yielded that the interspicular regions consist of coronal material of $T_e = 1.6 \times 10^6$ to 1.2×10^6 and $\log N_e = 8.5$ to 9.5, and that a decrease in T_e and an increase in N_e occur with decreasing height. (auth)

28948 MAGNETIC COUPLING OF THE ACTIVE CHROMOSPHERE TO THE SOLAR INTERIOR. Foukal, Peter (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Astrophys. J.; 173: No. 2, 439-44(15 Apr 1972).

Evidence is summarized to show that the configuration of field lines which governs the appearance of Hα fine structure in active regions is set mainly by motions in the subphotosphere where these lines are anchored. It is shown that Hα fine structure is directly coupled to a layer probably more than 5000 km below the photosphere, and little distortion of the strong fields is expected in the intervening layers. The shorter rotation period of active regions observed by Howard and others (compared to the photospheric gas) is interpreted as a result of this direct coupling of the strong field to a more rapidly rotating solar interior. The effects of dragging such a field through a photosphere of finite resistivity are briefly considered for features of various observed cross-sections. (auth)

28949 SOLAR RARE GASES AND THE ABUNDANCES OF THE ELEMENTS. Marti, Kurt; Wilkening, Laurel L.; Suess, Hans E. (Univ. of California, San Diego). Astrophys. J.; 173: No. 2, 445-50(15 Apr 1972).

A distinct component of the rare gases present in gas-rich meteorites and in gas-rich lunar material has been directly implanted by solar-particle radiation. The elemental abundance ratios in this component agree with those predicted by interpolation in accordance with abundance rules, using analytical values for Type I carbonaceous chondrites. The importance of this agreement in connection with astrophysical and cosmochemical problems is discussed. In particular, it appears that no major rare-gas fractionation takes place within the solar wind. Also, the agreement shows that the Sun has its normal complement of noble gases. This indicates that no significant gas-solid fractionation occurred during the formation of the solar nebula from the precursor interstellar cloud or during the formation of the Sun from the solar nebula. (auth)

28950 TEMPERATURE AND VELOCITY DIFFERENCES FOR COMPONENTS OF THE SOLAR WIND. Ponomarenko, Yu. B. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 771-7(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 976-84(Sep-Oct 1971).

A solar-wind model comprising electrons, protons, and α particles is considered. The molecular weight and relative velocity differences are found to decrease with distance from the Sun, and the temperature differences to increase. Near the base of the corona the temperatures of the components are approximately equal, but the α particles have a considerably lower velocity than the protons and electrons. At large distances the velocities of the components are approximately equal; the proton temperature is considerably lower than the electron and α-particle temperatures. (auth)

28951 STRUCTURAL MEASUREMENTS, ABSOLUTE PHOTOMETRY, AND POLARIMETRY OF THE CORONA AT THE TOTAL ECLIPSE OF SEPTEMBER 22, 1968. Khetsuriani, Ts. S.; Tetruashvili, E. I.; Kiladze, R. I.; Salukvadze, G. N.; Khatisov, A. Sh. (Astrophysical Observatory, Tbilisi, USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 778-88(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 985-97(Sep-Oct 1971).

The total solar eclipse of September 22, 1968 was photographed from the Yurgamysh site in the Kurgan district of western Siberia. For photometry of the corona a meniscus telescope system was used (objective diameter D = 13 cm, focal length F = 1 m), and for polarization measurements a telescope of aperture D = 10 cm and F = 50 cm. A polaroid sheet served as the analyzer. The photographs with both telescopes were taken through a red KS-10 filter on type 17 film. They were measured on a recording microphotometer equipped with a specially designed stage enabling concentric cross sections of the corona to be taken. The intensity was converted into absolute units. Isophotes of the corona were derived by the method of equidensity curves, and the structure of the corona was examined on prints made through a radial filter. In its geometrical shape and according to the photometric evidence the corona belongs to the premaximum type. The degree of polarization is higher in the rays than in the gaps between them. The polarization averaged over all position angles reaches a maximum near r = 1.6. The direction of the polarization plane is radial within the errors of measurement. (auth)

28952 ORIENTATION OF INTERPLANETARY SHOCK WAVES AS MEASURED BY SPACE PROBES AND THE POSITION OF CHROMOSPHERIC FLARES. Ivanov, K. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 789-93(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 998-1003(Sep-Oct 1971).

The relation between the orientation of interplanetary shock waves (according to measurements with space probes near the Earth) and the position of strong chromospheric flares is examined. The inclination of a shock wave to the ecliptic plane depends on the difference between the "heliolatitudes" of the corresponding flare and the projection of the Earth. The azimuth of the normal to the shock front tends to depend on the "heliolongitude" of the flare. For waves with a large inclination to the ecliptic ($\gtrsim 30°$), the angle between the normal to the shock front and the radius vector passing through the center of the Sun and the flare is very nearly a right angle (≈ 90 to $110°$). The presence of substantial departures from spherical and axial symmetry in the propagation of interplanetary shock waves is confirmed. (auth)

28953 SOLAR LINE PROFILES DETERMINED BY A DOUBLE-PASS DIGITAL SPECTROPHOTOMETER. Karpinskii, V. N.; Kokhan, E. K.; Pechinskaya, N. I. (Central Astromical Observa-

tory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 794-801(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 1004-12(Sep-Oct 1971).

In summer 1969 a systematic investigation of solar Fraunhofer-line profiles was initiated at Pulkovo, using a new double-pass spectrophotometer with digital readout on punched cards. Profiles of over 20 lines were measured at the center and the limb of the solar disk. The scanning rate was an order of magnitude faster than previously, with six intensity measurements being made each second in each of two channels, to an accuracy of 0.1% of the continuum intensity. The effects of ghosts and general scattered light were completely eliminated. For most of the observed central intensities the systematic error was less than 1 to 2%. All data were processed on a Minsk 22 computer. The observed intensity distribution in the λλ 5307.4 Fe I and 5435.9 Ni I lines is given. (auth)

28954 MASS DISTRIBUTION OF PROTOPLANETARY BODIES. Zvyagina, E. V.; Safronov, V. S. (Inst. of Terrestrial Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 810-17(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 1023-32(Sep-Oct 1971).

The mass distribution of protoplanetary bodies can be established by the general techniques of coagulation theory. The distribution function is usually described by an inverse power law $n(m) = cm^{-q}$. A qualitative study of the coagulation equation enables the sign of q to be determined for various ranges of variation in the mass m and for different forms of the coagulation coefficient as a function of m. If the bodies in the system suffer no fragmentation and the coagulation coefficient is proportional to the sum of the masses of the colliding bodies, then for all values of m except those close to the upper and lower limits of the n(m) distribution, the exponent will asymptotically approach the value $q_0 = 1.5$. This result agrees with the analytic solution obtained previously by one of the authors. The distribution is found to be stable. For values of m approaching the upper limit M of the distribution, the exponent q_0 is sharply lower; thus the distribution function for $m \lesssim 0.1$ M cannot be represented by a power law. As m approaches the lower limit of the distribution, q_0 diminishes only slightly (to 1.43). The coagulation coefficient in the protoplanetary cloud would have been a more complicated function of the masses of the colliding bodies. In the absence of fragmentation the characteristic expression for this coefficient for small bodies (as determined by their geometric cross section) implies that $q_0 = 1.54$. For large bodies, whose gravitational attraction significantly enlarges their collisional cross section, q_0 diminishes from 1.7 to 0.5 as the mass increases. Except for a small mass range including the very largest bodies, the mass distribution can be approximated by a power law with exponent $q_0 \approx 1.55 \pm 0.15$. The form of the asymptotic solution is independent of the form of the initial distribution function. Any distribution with $q < 2$ will approach an asymptotic law with exponent q_0 in the time required for the masses of the bodies to grow by several times. (auth)

28955 ATMOSPHERIC ELECTRICITY MEASUREMENTS AT WALDORF, MARYLAND DURING THE 7 MARCH 1970 SOLAR ECLIPSE. Anderson, R. V.; Dolezalek, H. (Naval Research Lab., Washington, D. C.). J. Atmos. Terrest. Phys.; 34: No. 4, 561-6(Apr 1972).

The Waldorf observatory for atmospheric electricity is described. Data are presented in which strong perturbations are produced by the action of the eclipse. It is shown that the diminution and subsequent restoration of eddy turbulence near the ground can produce effects of the type observed if adequate consideration is given to the existing electrical state of the atmosphere during the fully developed turbulence prior to the eclipse. (auth)

28956 ATMOSPHERIC ELECTRICITY, TURBULENCE, AND A PSEUDO-SUNRISE EFFECT RESULTING FROM A SOLAR ECLIPSE. Anderson, R. V. (Naval Research Lab., Washington, D. C.). J. Atmos. Terrest. Phys.; 34: No. 4, 567-72(Apr 1972).

Recordings made of several atmospheric electric parameters at the Naval Research Laboratory, Waldorf, Md. observatory during the eclipse of March 7, 1970 showed variations similar in nature to classical descriptions of the so-called sunrise effect. The recording of space charge density was spectrally analyzed with the fast Fourier algorithm, and the resultant power spectra were fitted to a power law spectral decay model. Since the decay exponent in this model is related to the fractions of the space charge resident on large and small ions, it is then possible to follow time variations in small-to-large ion ratios through the period of the eclipse. It is shown that the variations in the recorded atmospheric electric variables and in the spectral decay exponent are consistent with a strong diminution of turbulence near the ground as the Sun is obscured and the establishment of a thin layer above the ground in which a higher than normal density of small ions is produced by surface radioactivity. The subsequent resumption of turbulent mixing carries these ions upward, producing the "sunrise effect" variation pattern. The rapidity with which heating is restored is seen to be responsible for those differences in behavior which are observed. It is concluded that eclipse conditions provide a unique opportunity to investigate phenomena which are strongly influenced by atmospheric turbulence. (auth)

28957 POLARIMETRY OF THE DAYTIME SKY DURING SOLAR ECLIPSES. Rao, C. R. Nagaraja (Univ. of California, Los Angeles); Takashima, T.; Moore, J. G. J. Atmos. Terrest. Phys.; 34: No. 4, 573-6(Apr 1972).

The degree of linear polarization of the residual illumination in the umbral region was measured in different colors at intermediate levels in the atmosphere (10 to 12 km) during the total solar eclipses of May 30, 1965 and November 12, 1966. The objective was to examine the polarization characteristics of light that had been scattered more than once. It was found that, in the middle of the visible region of the electromagnetic spectrum (λλ 0.4 to 0.6 μ), multiply scattered light is partially linearly polarized (~20%) at the altitudes where the measurements were made. Results of similar ground-based measurements performed during the annular eclipse of September 11, 1969 are also briefly discussed. (auth)

28958 SHADOW BAND PHENOMENON. Quann, J. J.; Daly, C. J. (Goddard Space Flight Center, Greenbelt, Md.). J. Atmos. Terrest. Phys.; 34: No. 4, 577-83(Apr 1972).

Shadow bands are a phenomenon observed during eclipses of the Sun and visible only in the minutes immediately preceding and following totality. Prior to the solar eclipse of March 7, 1970, these bands had never been recorded by an experimental apparatus, accurately measured nor well analyzed. Data were gathered at the site established at Wallops Island, Virginia, in two ways; recording onto magnetic tape of the output from six collimated photocells whose spectral responses ranged from the ultraviolet to the infrared and visual and mechanical measurement of the orientation and motion of the bands. The recorded data were later processed using the output from a frequency spectrum analyzer. Most of the energy of the shadow bands ranges between 1 and 25 Hz, and appears not unlike plots of scintillation spectra. The onset, amplitude, and duration of the shadow bands seem to be spectrally related to the limb darkening of the Sun's photosphere. Other results of the experiment conclusively indicate that the shadow band phenomenon is a manifestation of atmospheric turbulence in the form of air packets of different density from that of their environment (density schlieren), made visible by the light from the crescent Sun. (auth)

28959 BRIGHTNESS OF FORBIDDEN OI LINES AND PROPERTIES OF SHADOW BANDS DURING THE ECLIPSE OF 7 MARCH 1970. Kerr, Donald E.; Sivjee, G. G.; McKinney, W.; Takacs, P.; Fastie, W. G. (Johns Hopkins Univ., Baltimore). J. Atmos. Terrest. Phys.; 34: No. 4, 585-92(Apr 1972).

During the total eclipse of March 7, 1970 two types of measurements were made at a site in the center of the eclipse track at Dam Neck, Virginia. The O I forbidden 5577-Å and 6300-Å lines were measured, looking vertically through the eclipse shadow. The intensities were approximately 1 kilorayleigh, essentially the values obtained in recent rocket measurements of normal day airglow at altitudes above 100 km. This is consistent with the hypothesis that these lines originate primarily at altitudes well above the shadow from mechanisms which are not appreciably perturbed by the approaching shadow. Measurements were also made of the time variation of intensity of incident light during the shadow-band period before second contact. There are sawtooth fluctuations with steep leading edges, as well as many high-frequency components of smaller amplitude. This time variation does not appear to be obviously related in a simple way to current theories of their production mechanisms, or to the visual appearance of shadow bands. (auth)

28960 ROCKET OBSERVATIONS OF SOLAR UV RADIATION DURING THE ECLIPSE OF 7 MARCH 1970. Smith, L. G. (GCA Corp., Bedford, Mass.). J. Atmos. Terrest. Phys.; 34: No. 4, 601-11(Apr 1972).

Photometers sensitive to narrow bands of radiation at Lyman-α (1216 Å) and at 2600 Å were included in the payloads of four Nike-Apache rockets flown from Wallops Island before and during the eclipse. At the center of totality the flux of Lyman-α from the solar corona was 0.15% of the flux from the unobscured Sun. The flux at second contact was 0.64%; at third contact, two observations gave 0.52 and 0.59%. The brightness of the chromosphere in Lyman-α decreased exponentially over the range 5 to 30 arcsec from the limb with a scale height of 3835 ± 70 km. In addition to the coronal and chromospheric Lyman-α a diffuse source was

found. This was restricted to within 20° of the Earth's horizon and was nearly uniform in azimuth. At 170 km the flux was about 3% of that from the unobscured Sun. The flux of Lyman-α during the eclipse was considered in relation to the observed variation in electron density. It was concluded that, in totality, the ionosphere near 80 km was not in equilibrium with the ionizing radiation and that the production rate for electrons was not negligible if the loss process was recombination; it was negligible if the loss process was attachment-like. (auth)

28961 ROCKET OBSERVATIONS OF SOLAR X-RAYS DURING THE ECLIPSE OF 7 MARCH 1970. Accardo, C. A.; Smith, L. G.; Pintal, G. A. (GCA Corp., Bedford, Mass.). J. Atmos. Terrest. Phys.; 34: No. 4, 613-20(Apr 1972).

The absorption profiles and residual fluxes of three bands of solar x rays were measured before and during the eclipse of March 7, 1970 at Wallops Island. In the bands 2 to 8 Å, 8 to 20 Å, and 44 to 60 Å the residual flux in totality was found to be respectively 5, 7, and 16% of the flux from the uneclipsed Sun. It is shown that the radiation maintaining the E layer varies in proportion to the 44- to 60-Å flux. In the D layer, ionization by the residual flux of 2 to 8 Å is less important in totality than is ionization of nitric oxide by Lyman-α. (auth)

28962 MEASUREMENTS OF SOLAR LYMAN-α RADIATION DURING THE ECLIPSE OF 7 MARCH 1970. Dickinson, P. H. G. (SRC Radio and Space Research Station, Slough, Eng.). J. Atmos Terrest. Phys.; 34: No. 4, 621-5(Apr 1972).

Measurements of solar hydrogen Lyman-α radiation before and during the eclipse at Nova Scotia are compared with computed values of the exposed area of the visible solar disc. At totality 0.2% of the flux remained, due to coronal emission. The intensity distribution over the visible disc was found to be quite uniform. The solar Lyman-α flux before the eclipse was found to have been 5.3 ± 1 ergs cm^{-2} s^{-1}(5.3 mW m^{-2}). Dayglow emissions were also detected and are attributed to Lyman-α multiply scattered by hydrogen in the Earth's atmosphere. Intensities near 150 km were found to be 28 ± 6 kilorayleighs in full Sun and 10 ± 2 kR for eclipse conditions varying from totality to 85% obscuration. (auth)

28963 SATELLITE LINES IN THE SOLAR X-RAY SPECTRUM OF HELIUM-LIKE MAGNESIUM. Parkinson, J. H. (Univ. of Leicester, Eng.). Nature (London) Phys. Sci.; 236: No. 66, 69-70(3 Apr 1972).

Observations of satellite lines to the resonance lines of several He-like ions were reported previously in the solar x-ray spectrum (Nat. Phys. Sci., 233: 44(1971)). Further measurements of such lines are reported here, using a new design of Bragg crystal spectrometer, having better sensitivity and resolution. The new instrument contained three ammonium dihydrogen phosphate crystals, and was launched on a Skylark rocket from Woomera on Nov. 30, 1971. The x-ray spectra of an active region are shown, together with wavelengths and intensities of lines in a scan near the Mg XI resonance line. All the lines observed on the previous flight were again observed and, in addition, several new lines were observed and some identified. Comparisons are made with calculations. The intensity of the satellite lines relative to the resonance line varies with temperature and a powerful new way of determining temperatures in the corona is offered. (UK)

28964 HYPERFINE STRUCTURE OF MULTIPLET LINES e^6D–y^6P OF MANGANESE I. Luc, P.; Gerstenkorn, S. (Paris Univ., Orsay, France). Astron. Astrophys.; 18: No. 2, 209-14(May 1972). (In French).

Three lines belonging to the e^6D-y^6P multiplet of manganese I exhibit hyperfine structures measurable in the solar spectrum between 8650 and 8750 Å. This exceptional possibility has partially its origin in the polarization of the s electrons by the 3d electrons. Indeed, this phenomen leads to an important extension of the hyperfine structure, but the measurements issued from the solar spectrum are limited by the width of absorption lines. The lines of the multiplet e^6D-y^6P were recorded, in emission, using two different high-resolution apparatus; first the Fabry–Perot spectrometer (Hypéac), and second the Fourier transform spectrometer. This study confirms the astronomical measurements, determines the hyperfine constants of the terms e^6D and y^6P, and compares the performance of the high-resolution spectrometers in this particular case. (auth)

Galaxies

Refer also to abstracts 28904 and 28919.

28965 EXPANDING AND ROTATING RING OF GAS 2.4 kpc FROM THE GALACTIC CENTER. Sanders, R. H. (Columbia Univ., New York); Wrixon, G. T. Astron. Astrophys.; 18: No. 1, 92-6(Apr 1972).

Observations made in the direction of the galactic center at negative velocities have shown that the large feature found by van der Kruit (1970) south of the plane at positive longitudes, extends also to negative longitudes with its velocity becoming more negative in the sense of galactic rotation. A kinematic model fitted to the expanding arm at +135 km/s also describes quite well the velocity distribution with longitude of the van der Kruit feature. This suggests the presence of a complete rotating and expanding ring of hydrogen about 2.4 kpc from the galactic center. (auth)

28966 POSSIBLE EXPLANATION OF THE ANOMALOUS COLUMNAR DENSITY OF NEUTRAL HYDROGEN IN THE DIRECTION OF ORION. Kovach, William S. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio). Astrophys. J.; 173: No. 2, 287-91(15 Apr 1972).

The anomalous H^0 columnar density found from Lα and 21-cm measurements in the direction of Orion may be explained on the basis of charged dust grains. It is found that the 21-cm emission line may be stimulated by surface electric fields acting on the hyperfine levels in the $S_{\frac{1}{2}}$ state. A density of $\sim 10^4$ H^0 atoms on the grain's surface is required to bring the two observations into agreement. The steady state H^0 density on the grain surface is calculated for a range of free H^0 densities and temperatures. It is found that, for the types of grains envisioned by Hollenbach and Salpeter, a surface density of $\sim 10^4$ H^0 atoms can be easily achieved for grains of radius ≥ 0.1 μ. (auth)

28967 BLUE CONDENSATIONS ASSOCIATED WITH ELLIPTICAL AND S0 GALAXIES. Stockton, Alan (Univ. of Arizona, Tucson). Astrophys. J.; 173: No. 2, 247-56(15 Apr 1972).

Spectroscopic observations have been obtained for a number of systems for which one or more faint blue knots are found in the vicinity of an elliptical or SO galaxy. Of particular interest are NGC 3561 and IC 1182, which have luminous bridges connecting the galaxies and the blue knots. The spectra of the blue knots show emission lines characteristic of moderate-excitation H II regions, and the continuum radiation is dominated by light from early-type stars. The available observational evidence suggests that these emission knots, with dimensions of 2 to 3 kpc and absolute magnitudes of -16 to -17, have recently condensed from the gaseous medium surrounding the galaxies with which they are associated. (auth)

28968 FURTHER OBSERVATIONS OF MAFFEI 2 AT 4.5 AND 2.8 CENTIMETERS. Bell, M. B. (National Research Council of Canada, Ottawa); Seaquist, E. R. Astrophys. J.; 173: No. 2, 257-8(15 Apr 1972).

Further measurements of the angular size, flux density, and position of Maffei 2 at 4.5 and 2.8 cm are reported. (auth)

28969 APPLICATION OF THE DENSITY-WAVE THEORY OF SPIRAL STRUCTURE: SHOCK FORMATION ALONG THE PERSEUS ARM. Roberts, William W. Jr. (Univ. of Virginia, Charlottesville). Astrophys. J.; 173: No. 2, 259-83(15 Apr 1972).

An examination of (1) recent optical data on O associations, young open clusters, H II regions, and interstellar absorption lines and (2) recent high-resolution 21-cm hydrogen maps of the Perseus spiral arm indicates that the systematic motion of order up to 20 km s^{-1} associated with the interstellar medium may be a significantly more extended phenomenon than previously recognized, stretching from a longitude of $l = 100°$ all the way around to $l = 200°$ and perhaps beyond. In light of the observational data, a model based on the density-wave and galactic-shock-wave concepts is proposed for the Perseus arm. The model considered is the two-armed spiral shock (TASS) model that delineates the large-scale spiral structure and describes the large-scale motion of the interstellar gas, and the young optical objects born out of the gas, over the galactic disk. In this model, the Perseus arm is visualized to consist of a galactic shock wave embedded in a background density wave. The systematic motion observed along the entire length of the Perseus arm can be accounted for as the systematic motion predicted in the TASS model. Splitting of an H I feature into multiple subcomponents of the type found in observed profiles of neutral hydrogen arises rather naturally in the presence of a galactic shock. When the observational data are interpreted through the TASS model, the apparent discrepancy between the position of the optical spiral arm and that of the neutral-hydrogen spiral arm is found to disappear, and the overall Perseus feature becomes one composite arm. Secondary arms are found to be possible in the outer parts of the TASS model, and these bear some resemblance to the secondary arms, "spurs," and "feathers" which are often observed in the outer parts of external spiral galaxies and our own Milky Way system. (auth)

28970 MASS OF NEUTRAL ATOMIC HYDROGEN IN THE GALAXY. Goldstein, Samuel J. Jr. (Univ. of Virginia, Charlottesville). Astrophys. J.; 173: No. 2, 285-6(15 Apr 1972).

Twenty-one-centimeter observations of the galactic poles lead to a mass of optically thin neutral atomic hydrogen in the Galaxy in the range 2.3 to 2.9 $\times M_{\odot}$ on the assumption that the hydrogen is a uniform disk with a radius of 15 kpc. (auth)

28971 POPULATION OF HIGH ATOMIC LEVELS AT LOW TEMPERATURES. Dupree, A. K. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J.; 173: No. 2, 293-300(15 Apr 1972).

Calculations of b_n coefficients are presented for atomic levels $50 \leq n \leq 250$ under the conditions of low temperature ($T_e = 10$, 20, 100, 1000°K), density ($10^{-3} \leq N_e \leq 10^3$ cm^{-3}), and thermal radiation fields that may be expected in the interstellar medium. For $T_e \lesssim 20$°K and $N_e \lesssim 1$ cm^{-3}, the populations of high levels ($n \sim 110$) can be more than a factor of 10 less than their values in thermodynamic equilibrium. A thermal continuum such as that produced by an H II region is found to substantially change both the departure coefficients b_n and their slope $1 - b_n/b_{n+1}$ under conditions of low density. (auth)

28972 ABUNDANCES OF INTERSTELLAR CH AND CH^+ RADICALS. Frisch, Priscilla (Univ. of California, Berkeley). Astrophys. J.; 173: No. 2, 301-16(15 Apr 1972).

The spectra of 30 O and B stars were measured for the equivalent widths of the interstellar CH and CH^+ lines. Conversion factors were determined between visual estimates of weak line intensities and equivalent widths. Column densities of CH and CH^+ were determined with the use of the Strömgren curve of growth. A brief consideration of molecular equilibrium showed that with favorable choices of parameters, both the radiative-association and surface-reaction models are able to explain, within a factor of 2, the observations in ζ Oph, ξ Per, and 20 Tau. Correlations between line intensity and color excess were searched for. Column densities of CN were determined from equivalent widths measured by Clauser and Thaddeus and by Dunham, and were compared with CH column densities. (auth)

28973 INTERSTELLAR FORMALDEHYDE. I. THE COLLISIONAL PUMPING MECHANISM FOR ANOMALOUS 6-CENTIMETER ABSORPTION. Thaddeus, P. (Goddard Inst. for Space Studies, New York. Columbia Univ., New York). Astrophys. J.; 173: No. 2, 317-42(15 Apr 1972).

"Anomalous" absorption by formaldehyde in diffuse dust clouds—6-cm line absorption in the absence of a continuum source—is generally conceded to result from a pump which maintains the 6-cm excitation temperature below 2°K, producing thereby absorption of the microwave background. A quantum-mechanical treatment is given of the collisional-pumping process which Townes and Cheung suggest will cool the 6-cm levels by the required amount. It is shown that quantum effects probably limit the proposed process to regions where the kinetic temperature $T_k \gtrsim 45$°K, and may even suppress it altogether. (Hydrogen molecules are taken for the colliding neutral particles, but essentially the same results are expected from H or He collisions.) Electron impact, moreover, is shown to heat the 6-cm transition at essentially all T_k, and would suppress the proposed collisional cooling in regions having $n_e/n_{H_2} \gtrsim 10^{-5}$, even if it were to occur in less ionized regions. Since radio observations of OH, H I, and CO indicate T_k to be well below 45°K in a typical dark nebula where anomalous absorption is observed (Heiles's Cloud 2), and since the required combination of high T_k and low n_e/n_{H_2} is difficult to reconcile with thermal and ionization equilibrium, it is concluded that collisions are probably not the cause of anomalous absorption. (auth)

28974 OBSERVATIONS OF THE DIFFUSE GALACTIC LIGHT. Roach, F. E. (Battelle Northwest, Richland, Wash.); Smith, L. L.; Pfleiderer, J.; Batishko, C.; Batishko, K. Astrophys. J.; 173: No. 2, 343-52(15 Apr 1972).

Systematic observations during five nights were made with a field of 137 arc seconds at a fixed declination of 20°42′ through one arm of the Milky Way over a range of right ascension from 257 to 336°. Corrections for zodiacal light, airglow, and integrated starlight leave a residual that is interpreted as the diffuse galactic light. The residual, plotted against galactic latitude, suggests that the diffuse light in the sample studied emanates from several discrete sources. (auth)

28975 DETAILED UBV PHOTOMETRY OF THE PECULIAR GALAXY NGC 1023. Derevyanko, V. G. Uch. Zap. Leningrad. Gos. Univ., No. 359, Ser. Mat. Nauk; No. 47, 32-9(1971). (In Russian).

The U, B, V intensity distribution and distribution of the colors U − B and B − V along the image of NGC 1023 were found. The color indices and the spectrum of the peculiar region I show that this region is not an ejection from the galaxy. (auth)

28976 GENERATION OF THE LARGE-SCALE GALACTIC MAGNETIC FIELD. Vainshtein, S. I.; Ruzmaikin, A. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Novosibirsk, USSR. Inst. of Applied Mathematics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 714-19(Mar-Apr 1972). Translated from Astron. Zh.; 48: No. 5, 902-9(Sep-Oct 1971).

The generation of the large-scale galactic magnetic field is discussed. The poloidal field components H_r, H_z produce the toroidal component H_φ by means of differential rotation. Steenbeck's turbulence mechanism can accomplish the reverse process; generation of the poloidal by the toroidal field. The poloidal component of the generated field is found to be quadrupole. A possible difficulty is pointed out with the hypothesis of a primordial origin for the magnetic fields of galaxies. (auth)

28977 NON-VELOCITY RED SHIFTS IN GALAXIES. De Vaucouleurs, G.; De Vaucouleurs, A. (Univ. of Texas, Austin). Nature (London); 236: No. 5343, 166(24 Mar 1972).

Some comments are made on Nature 234: 505(1971) with regard to nonvelocity redshifts in galaxies, and some omissions are pointed out. These refer to the Holmberg effect (a supposed systematic error depending on galaxy type, exposure time, and nuclear magnitude), and the structure of the Virgo cluster galaxies, leading to the conclusion that nonvelocity shifts must be considered a real possibility. (UK)

28978 INTERSTELLAR ABSORPTION IN THE DIRECTION OF MAFFEI 1 AND 2. Kohoutek, L.; Haug, U. (Hamburger Sternwarte, Hamburg). Nature (London) Phys. Sci.; 236: No. 65, 55-6(27 Mar 1972).

Using plates obtained with the Hamburg Schmidt telescope, an attempt was made to trace the variation of absorption with distance by photographic UBV photometry of early-type stars. In a circular area of radius 1°, centered in Maffei 1, 467 stars were examined. The data indicated that stars on reddening lines leading to intrinsic colors should be unambiguously B-type stars. The total visual absorption was derived from the intrinsic color and from the color excess. The absorption was found to increase rapidly with distance, as a consequence of interstellar matter in the local spiral arm, up to ~1.5 kpc; between 2 and 7 kpc no substantial increase over the mean value could be detected. The corrected relation between distance and total visual absorption is shown graphically. The total visual absorption in the Galaxy for Maffei 1 was estimated as 3.1 ± 0.4 mag., and the absorption for Maffei 2 was practically the same. The data indicate that the distance of Maffei 1 is greater by a factor of 2.5 to 3 than earlier estimates, that is about 3 Mpc, if the system is a giant elliptical galaxy; but with changing absorption the spectral energy distribution of the nucleus might no longer be compatible with that of a giant elliptical galaxy. (UK)

28979 NEW CONTRIBUTION TO THE STUDY OF THE CARINA SPIRAL FEATURE. Bigay, J. H. (Observatoire, Lyon); Garnier, R.; Georgelin, Y. P.; Georgelin, Y. M. Astron. Astrophys.; 18: No. 2, 301-9(May 1972). (In French).

A 4.5 × 4.5° region in Carina was studied. With Perot–Fabry rings, radial velocities of 10 H II regions were obtained; noncircular motions were found only in the outer edge of the spiral feature, they were $V_{obs} - V_{mod} = -3.7$ km s^{-1}. A comparison with radio observations was made. From spectroscopic and photoelectric observations distances of 29 exciting stars or early-type stars were obtained; these observations proved that at this longitude one is looking tangentially along a spiral arm between 2 and 5 kpc. (auth)

Cosmology

Refer also to abstracts 28915, 29338, 29363, 29368, and 29894.

28980 ABSORPTION OF GRAVITATIONAL ENERGY BY A CONDUCTING FLUID IN THE PRESENCE OF MAGNETIC FIELDS. Esposito, F. Paul (Univ. of Chicago). Astrophys. J.; 173: No. 2, 423-30(15 Apr 1972).

The equations that determine the response of hydromagnetic systems to incident gravitational radiation are derived in the linearized approximation to general relativity. These equations are solved for a uniform incompressible fluid occupying a half-space region in the presence of a uniform magnetic field normal to the free surface of the fluid. It is shown that energy absorption takes place in a surface layer of depth $(\eta/2\omega)^{1/2}$. It is also shown that gravitational radiation can excite Alfvén waves in the system. (auth)

28981 DIAMETER FUNCTION AND LUMINOSITY FUNCTION OF GALAXIES. Karachentsev, I. D.; Karachentseva, V. E.; Shapovalova, A. I.; Jaakkola, Toivo (Kiev State Univ. Univ. of Oulu, Finland). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 728-36(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 922-33(Sep-Oct 1971).

The luminosity function $\varphi(M)$ and diameter function ψ (log D) were derived for galaxies having known radial velocities. A discussion is given of how the form of $\varphi(M)$ is affected if the observational material is restricted by the minimum radial velocity for a galaxy. The behavior of $\varphi(M)$ depends little on the composition of the sample—whether "pure" field galaxies, or members of pairs, groups, or clusters. The functions log $\varphi(M)$ and log ψ (log D) can be represented by two straight-line segments with the turning point at $M \approx -20^m$ and $\log D_{kpc} \approx 1.1$, respectively. Lists of dwarf galaxies are used to determine the diameter function for 88 members of the Local Group and the M81 and M101 groups. The slope of the log ψ (log D) relation is approximately the same for the members of nearby groups and for field galaxies within the range $0 < \log D_{kpc} < 1.0$. The distribution has an absolute maximum at $\log D_{kpc} \approx 0$. Galaxy counts on the Palomar Sky Atlas prints for seven clusters indicate substantial differences in the slope of the log ψ (log D) relation. Characteristic bends and peaks are also suspected in the diameter function. At its faint end the logarithmic diameter function averaged over seven clusters exhibits practically the same slope as for field galaxies, but the turning point (at log $D_{kpc} \approx 1.4$) is shifted toward larger-sized galaxies. The composite $\varphi(M)$ and ψ (log D) functions are displayed graphically for the ranges $-23^m < M < -9^m$ and $1.8 > \log D_{kpc} > -1.0$. Moments of the galaxy diameters and luminosities were computed from the graphs and tabulated. For a Hubble constant h = 75 km · sec^{-1} · Mpc^{-1} and a mass/luminosity ratio $f = 10 f_\odot$, the average density of matter in the Universe was found to be $\rho = 2.0 \times 10^{-31}$ g/cm^3. (auth)

28982 ORBITAL PERIODS IN THE RESTRICTED TWO-BODY PROBLEM OF GENERAL RELATIVITY, INCLUDING THE COSMOLOGICAL CONSTANT. Kurmakaev, Z. Kh. (Astrophysical Inst., Alma-Ata, USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 836-9(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 1056-60(Sep-Oct 1971).

The anomalistic and sidereal periods for the restricted two-body problem are determined approximately in coordinate and proper time. A more accurate equation is obtained for the pericenter shift, corrected for the cosmological constant. (auth)

28983 COSMOLOGICAL MODELS WITH TWO FLUIDS. I. ROBERTSON–WALKER METRIC. McIntosh, C. B. G. (Monash Univ., Clayton, Australia). Aust. J. Phys.; 25: No. 1, 75-82(Feb 1972).

Exact solutions in terms of elementary functions are given for flat, homogeneous and isotropic, relativistic cosmological models which contain two fluids, each with an equation of state of the form $p = (\nu_i - 1)\rho$ where p is the pressure, ρ is the density, $\nu_i (i = 1,2)$ is a constant, and $\nu_1/\nu_2 = (1 + 2n)/2(1 + n)$ or $2(1 + n)/(3 + 2n)$, n = 0,1,2. ... For other forms of ν_1/ν_2, the relevant solution is given in terms of a hypergeometric function. The cases when one of the ν's is equal to $\frac{4}{3}$ or 2 are analogous to models with a Robertson–Walker metric with $k = \pm 1$ and to anisotropic models of the type discussed by Jacobs, respectively. All solutions for the two-fluid models can be written in terms of elementary functions when $\nu_1 = 0$, which is analogous to a cosmological constant. The fact that all two-fluid solutions with $\nu_1 = \frac{4}{3}$ which can be written in terms of elementary functions are given means that all such one fluid solutions with $k = \pm 1$ are given. (auth)

28984 COSMOLOGICAL MODELS WITH TWO FLUIDS. II. CONFORMAL AND CONFORMALLY FLAT METRICS. McIntosh, C. B. G.; Foyster, J. M. (Monash Univ., Clayton, Australia). Aust. J. Phys.; 25: No. 1, 83-9(Feb 1972).

Solutions are given for two-fluid cosmological models when the Robertson–Walker metric in its usual form is replaced by "conformal" and "conformally flat" forms. In these cases the solutions can be written in terms of elementary functions when $(3\nu_1 - 2)/(3\nu_2 - 2) = 1 - m^{-1}$, where m = 1.2.3. The relation of these solutions to one-fluid solutions with $k = \pm 1$ is also discussed. (auth)

28985 VELOCITY-DOMINATED SINGULARITIES IN IRROTATIONAL HYDRODYNAMIC COSMOLOGICAL MODELS. Liang, E. P. T. (Univ. of California, Berkeley). J. Math. Phys. (N. Y.); 13: No. 3, 386-93(Mar 1972).

Irrotational perfect fluid solutions of the Einstein equations with an equation of state $p = \gamma\rho$ are considered. "Velocity-dominated" singularities of these solutions are defined, a notion previously introduced for dust models. It is demonstrated explicitly that uniquely and invariantly defined inner metric tensors, extrinsic curvature tensors, and scalar bang-time functions can be assigned to these singularities, as in the dust case. The effects of a time-varying equation of state and viscosities on these singularities are studied and it is shown by order-of-magnitude estimates that they do not change the structure of the singularity provided $\gamma > 0$. Some known exact perfect fluid solutions, both homogeneous and inhomogeneous, are listed as examples. (auth)

28986 INTENSITY AND SPECTRUM OF THE DIFFUSE X-RAY BACKGROUND. Manchanda, R. K.; Danjo, A.; Sreekkantan, B. W. (Tata Inst. of Fundamental Research, Bombay). Nature (London) Phys. Sci.; 236: No. 66, 67-8(3 Apr 1972).

Reference is made to experiments conducted at balloon altitudes to determine the intensity and spectrum of the diffuse cosmic x-ray background at energies >20 keV. In all of these the method of derivation was based on the growth curves obtained by plotting the counting rates in different energy channels of an x-ray telescope as a function of atmospheric depth for altitudes >100 g cm^{-2}, and a few typical growth curves are shown and discussed, particularly in regard to discrepancies between calculated and experimental attenuation curves. (UK)

28987 UNIQUENESS OF THE KERR–NEWMAN BLACK HOLES. Wald, Robert (Princeton Univ., N. J.). J. Math. Phys. (N. Y.); 13: No. 4, 490-9(Apr 1972).

It is proven that the Kerr–Newman space–times with $e^2 + a^2 < m^2$ are the only electrovac black hole solutions of Einstein's equations which can be obtained by analytic variation of the space–time geometry starting from the Schwarzschild solution. (auth)

Planetary Phenomena

Refer also to abstracts 28954 and 29322.

28988 U–Th–Pb ANALYSES OF SOIL FROM THE SEA OF FERTILITY. Tera, Fouad; Wasserburg, G. J. (California Inst. of Tech., Pasadena). Earth Planet. Sci. Lett.; 13: No. 2, 457-66(Jan 1972).

The isotopic composition of lead was determined on soil samples from two levels of the Luna 16 core. The lead was distinctly radiogenic and yielded $^{207}Pb/^{206}Pb$ model ages of 4.8 AE. This is interpreted as reflecting early lunar differentiation processes. The most reliable value of $^{208}Pb/^{204}Pb = 111$ shows that the Luna 16 soils are significantly less radiogenic than found for other lunar soils. The elemental concentrations are Pb ~ 0.9 ppM, U ~ 0.3 ppM, and Th ~ 1.2 ppM, with a Th/U ratio of 3.8. The U concentration is the lowest so far found for lunar soils. (auth)

28989 DETERMINATION OF 29 ELEMENTS IN LUNA 16 SOIL BY NONDESTRUCTIVE ACTIVATION ANALYSIS. Jerome, Dominique Y. (Univ., Paris); Philippot, Jean-Claude; Brichet, Evelyne. Earth Planet. Sci. Lett.; 13: No. 2, 436-40(Jan 1972).

Abundances of 29 elements, including 11 rare earth elements were obtained in Luna 16 soil (sample L-16-19, 118) via instrumental neutron activation analysis. Sodium, REE, Hf, and Th are less abundant than in Apollo 11, 12 and 14 soils. The Eu negative anomaly in comparison with chondrites is the smallest ever found in lunar regolith. Europium abundances in the three mare sites and in the Fra Mauro region cluster around 2 ppM (1.75 to 2.25 ppM), whereas light REE vary by a factor of 6 from Luna 16 to Apollo 14 soil. In general, the chemical composition of the Sea of Fertility resembles that of the Sea of Tranquillity although the K, REE, and P-rich components seem less prominent in the soil of the former site, possibly because of the greater distance from the Sea of Rains. (auth)

28990 FOSSIL TRACK AND THERMOLUMINESCENCE STUDIES OF LUNA 16 MATERIAL. Walker, R.; Zimmerman, D. (Washington Univ., St. Louis). Earth Planet. Sci. Lett.; 13: No. 2, 419-22(Jan 1972).

Track densities in feldspar crystals L16A14 and L16G14 (6 to 8 cm and 29–21 cm) ranged from 2.5×10^8/cm^2 to $>2 \times 10^9$/cm^2. No significant difference was found between the two positions. The track densities were similar to those observed in heavily irradiated samples of Apollo 11, 12, and 14 and indicated that these two positions are composed of well mixed materials from a number of sources. This was in contrast to a number of fines samples from Apollo 12 and 14 which were less irradiated and represent relatively recent additions to the lunar surface. Thermoluminescence measurements showed the same natural TL (normalized to beta sensitivity) at the two depths within 15%. This was similar to the Apollo 12 core results at the same depths.

The TL sensitivity of the Luna 16 core was very low (about 50 times less than the Apollo 12 core). The sensitivity of a number of lunar fines was shown to roughly correlate with their average uranium concentration, suggesting that the TL may be produced by a trace mineral high in uranium or closely associated with a high uranium phase. Subsequent experiments showed that indeed only a small fraction of the grains contribute the bulk of the TL. (auth)

28991 EXTREME RADIATION DAMAGE IN SOIL FROM MARE FECUNDITATIS. Phakey, P. P.; Price, P. B. (Univ. of California, Berkeley). Earth Planet. Sci. Lett.; 13: No. 2, 410-18(Jan 1972).

High-voltage electron microscopy was used to compare radiation effects in micron-size soil grains from the Luna 16 site (Mare Fecunditatis) and the four Apollo landing sites. Radiation damage by heavy solar particles is strikingly greater in the Luna 16 sample than in the other four samples. It is suggested that less movement of the soil at Mare Fecunditatis has taken place, perhaps because of its proximity to the limb and consequent lower exposure to energetic electrons in the Earth's magnetospheric tail, which would cause electrostatic agitation of fine particles. (auth)

28992 PARTICLE-TRACK RECORD OF THE SEA OF PLENTY. Comstock, G. M.; Fleischer, R. L.; Hart, H. R. Jr. Earth Planet. Sci. Lett.; 13: No. 2, 407-9(Jan 1972).

The particle track densities were measured in 36 grains taken from two levels of the soil column returned from the Sea of Plenty by Luna 16. One sample was from near the surface, the other was from about 30 cm depth. All but one of the grains contained very high track densities, $>10^8/cm^2$. It was concluded that all of the Luna 16 soil has been irradiated very close to the surface, that there has been little or no "recent" admixture of previously shielded material from below 30 cm, and that the regolith is both unusually thin at the Luna 16 site and extremely old (~3 by and more). (auth)

28993 RARE GAS STUDIES IN LUNA-16-G-7 FINES BY STEPWISE HEATING TECHNIQUE. A LOW-FISSION SOLAR-WIND Xe. Kaiser, Wulf A. (Univ. of California, Berkeley). Earth Planet. Sci. Lett.; 13: No. 2, 387-99(Jan 1972).

He, Ne, Ar, Kr, and Xe were examined in a dust sample (≤125 μm) of Luna-16 in twelve temperature steps with especially small intervals in the low-temperature range (80°C steps). The gas concentrations, as well as their relative abundances, are in general agreement with values reported by Vinogradov (1971) for Luna-16 and values found in Apollo 11 fines except for Ne. (W.D.M.)

28994 NEUTRON CAPTURE OF Gd AND Sm IN THE LUNA 16, G-2 SOIL. Russ III, G. P. (California Inst. of Tech., Pasadena). Earth Planet. Sci. Lett.; 13: No. 2, 384-6(Jan 1972).

The Gd and Sm isotopic compositions were measured in the Luna 16, G-2 soil. This sample has the largest low-energy neutron fluence $\{\psi = 5.9 \times 10^{16}\ n/cm^2\ (E < 0.18\ eV)\}$ yet observed in a lunar sample. The ratio of the number of neutrons captured per atom by ^{149}Sm to ^{157}Gd is 0.76 which is distinct from the value of 0.86 observed at the Apollo 11, 12, and 14 sites. This indicates a softer neutron energy spectrum at the Sea of Plenty. (auth)

28995 GAS RETENTION AND COSMIC-RAY EXPOSURE AGES OF A BASALT FRAGMENT FROM MARE FECUNDITATIS. Huneke, J. C.; Podosek, F. A.; Wasserburg, G. J. (California Inst. of Tech., Pasadena). Earth Planet. Sci. Lett.; 13: No. 2, 375-83(Jan 1972).

An $^{40}Ar-^{39}Ar$ gas retention age and an $^{38}Ar-^{37}Ar$ cosmic-ray exposure age were determined on a total rock sample of the basalt fragment B-1 returned from Mare Fecunditatis by the Luna 16 mission. This sample showed large low-temperature loss of radiogenic ^{40}Ar but defined a reasonably good high-temperature plateau at 3.45 ± 0.04 AE. This was presumed to date a period of igneous activity in Mare Fecunditatis. This activity is later than that at Mare Tranquillitatis but earlier than at Oceanus Procellarum and Mare Imbrium. The cosmic ray exposure age is 475 m.y. (auth)

28996 SPACE RESEARCH XI. VOLUME 1. Proceedings of Open Meetings of Working Groups of the Thirteenth Plenary Meeting of COSPAR, Leningrad, USSR, May 20–29, 1970 and of the Symposium on Remote Sounding of the Atmosphere, Leningrad, USSR, May 25–26, 1970. Kondrat'ev, K. Ya.; Rycroft, M. J.; Sagan, C. (eds.). Berlin; Akademie-Verlag (1971). 774p. (In English and French). (CONF-700568-(Vol.1)).

The meeting was concerned not only with the exploration of outer space but with the application of space vehicles and remote sounding devices to the exploration of the various parts of the Earth's atmosphere. The majority of the papers describe experimental techniques or results; in addition, a few theoretical studies are presented. Topics covered in this volume include the moon, planets, cosmic dust, solid earth physics, and remote sounding of the atmosphere. (W.D.M.)

28997 SPACE RESEARCH XI. VOLUME 2. Proceedings of Open Meetings of Working Groups of the Thirteenth Plenary Meeting of COSPAR, Leningrad, USSR, May 20–29, 1970 and of the Symposium on Remote Sounding of the Atmosphere, Leningrad, USSR, May 25–26, 1970. Kondrat'ev, K. Ya.; Rycroft, M. J.; Sagan, C. (eds.). Berlin; Akademie-Verlag (1971). 667p. (In English and French). (CONF-700568-(Vol.2)).

Topics covered in this volume include the neutral atmosphere, ionosphere, solar–terrestrial relations, and astronomical measurements. (W.D.M.)

28998 80 MHz MEASUREMENTS OF JUPITER'S SYNCHROTRON EMISSION. Slee, O. B. (CSIRO, Epping, Australia); Dulk, G. A. Aust. J. Phys.; 25: No. 1, 103-5(Feb 1972).

Flux densities at 80 MHz at Culgoora gave an average value of 6.0 ± 0.7 f.u. for Jupiter over 16 sets of observations between February and May 1970. (Australia)

28999 MEASUREMENTS OF THE PHASE DEPENDENCE OF THE 8.2-mm RADIO EMISSION FROM VENUS. Vetukhnovskaya, Yu. N.; Kuz'min, A. D.; Losovskii, B. Ya. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 5, 818-21(Mar-Apr 1972).

Translated from Astron. Zh.; 48: No. 5, 1033-7(Sep-Oct 1971).

Measurements were obtained of Venus' brightness temperature at 8.2-mm wavelength as a function of the phase angle of the planet's solar illumination throughout a complete phase cycle. The brightness temperatures of the light and dark sides of Venus averaged over the apparent disk were equal at this wavelength, to within 1%. This result suggests that the daytime and night temperatures of Venus' atmosphere do not differ appreciably at heights in the range 20 to 50 km. (auth)

29000 GEOCHEMICAL EVIDENCE FOR THE ORIGIN OF THE MOON. O'Keefe, John A. (Goddard Space Flight Center, Greenbelt, Md.). Naturwissenschaften; 59: No. 2, 45-52(Feb 1972).

The Moon's crust is deficient in those elements that tend to dissolve in molten iron rather than in molten silicates. Following theories constructed to explain the similar deficiencies in the Earth, they are attributed to the leaching out of these elements by molten iron. In the case of the Earth, these elements went down to form the core; but the Moon has no core. From the Moon's mean density it is clear that there can be at most only a very little free iron in the Moon; from considerations of moment of inertia and mechanical strength the upper limit can be set at 1 to 2%. The obvious solution of this paradox is to suppose that the Moon separated from the Earth after the formation of the core. This was followed by an episode of heating from the outside, possibly due to tidal interaction, and formation of a large common atmosphere for Earth and Moon, which ablated away much of the original lunar mass. Since this time, the heated zone of the Moon has gradually migrated toward the center. (auth)

29001 NOTES ON THE AMPLIFICATION OF MAGNETIC FIELD VARIATIONS ON THE LUNAR SURFACE. Nagata, Takesi (Tokyo Univ.). J. Geomagnet. Geoelec.; 23: No. 1, 101-6(1971).

Magnetic-field variations were appreciably amplified on the lunar surface in comparison with the ambient-field variations as indicated from a Lunar Surface Magnetometer set by the Apollo-12 Mission. A comparison with Explorer-35 magnetometers indicates a larger amplitude of variation with the LSM. The wave forms of the field variation observed by the two magnetometers are exactly the same within the accuracy of time resolution in both magnetometers. This may imply that the magnetic-field variations are amplified particularly on the Moon's surface. The toroidal magnetic field is generated by the electromotive-force-associated Moon–solar-wind interaction. The other magnetic field generated by the electrically conductive Moon is the time-varying poloidal field, which is essentially due to the electric currents electromagnetically induced within the Moon. Formulation is given for the magnetic fields. (J.C.W.)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric Phenomena

Refer also to abstracts 28945, 28955–28961, and 29862.

29002 (AD–732748) HALL CONDUCTIVITY CONTRIBUTIONS TO STRIATION FORMATION IN IONOSPHERIC PLASMA CLOUDS. Ossakow, Sidney L. (Naval Research Lab., Washington, D. C.). Nov 1971. 13p. (NRL-MR–2354). NTIS.

Hall conductivity contributions to ionospheric plasma cloud striation formation are calculated by considering the case where the ambient electric field is parallel to the equilibrium cloud density gradient and both are perpendicular to the geomagnetic field. The ambient electric field produces Hall currents in the cloud along the density perturbation (assumed perpendicular to the density gradient and magnetic field). Plasma cloud–background ionosphere coupling is included in the analysis. The growth rate of the instability is modified by the ratio of cloud Hall conductivity to cloud Pedersen conductivity compared with the case when the ambient electric field is perpendicular to the density gradient and only Pedersen conductivity contributions are considered. (auth) (NTIS)

29003 (AD–733563) PHOTOMETRIC STUDIES OF MODIFIED IONOSPHERIC BEHAVIOR. Final Report, October 27, 1969–June 30, 1971. Biondi, M. A.; Hake, R. D.; Sipler, D. P. (Pittsburgh Univ., Pa.). Aug 1971. Contract F30602-70-C-0099. 29p. (RADC-TR–71-222(Pt.B)). NTIS.

The method is described for detecting radio-frequency heating of the electrons in the F region through attendant effects on the intensity of radiation from excited oxygen atoms in that region of the ionosphere. The changes in the F region of the ionosphere produced by rf energy from a powerful (1.6-MW) ground-based transmitter at Platteville, Colorado, were detected optically by a spatial-scanning filter photometer constructed for the purpose. At low electron temperatures and small rf heating, the intensity of the atomic oxygen (^1D to ^3P) 6300-Å radiation is decreased (suppressed) as a result of reduced electron–ion recombination production of excited oxygen atoms in the ^1D state. At higher electron temperatures and/or stronger rf heating, the 6300-Å intensity is increased (enhanced) as a result of electron impact excitation of ground-state (^3P) oxygen atoms to the excited (^1D) state. (auth) (NTIS)

29004 (AD–734256) SIMULATION OF THE IONOSPHERE UTILIZING MICROWAVE ION GENERATION TECHNIQUES. Final Report, March–June 1971. Busby, M. R.; Gilley, B. W. (Arnold Engineering Development Center, Arnold Air Force Station, Tenn. ARO, Inc., Arnold Air Force Station, Tenn.). Dec 1971. Contract F40600-72-C-0003. 54p. (AEDC-TR–71-254). NTIS.

An experimental investigation of the simulation of the environment encountered in the lower regions of the ionosphere (50 to 500 km) was conducted at AEDC. Microwave cavities were utilized in conjunction with a converging-diverging nozzle and cryogenically pumped densities. A platinum, cylindrical, electrostatic probe was used to measure the voltage-current characteristics of the low-density plasma in the nozzle exit plane. For exit plane Mach numbers of 2.86 to 3.17, ion densities of 575,000 to 1,690,000/cm^3 and electron temperatures of 3000 ± 900°K were calculated, using the electrostatic probe characteristics. (auth) (NTIS)

29005 (N–72-12741) LOCAL-TIME SURVEY OF PLASMA AT LOW ALTITUDES OVER THE AURORAL ZONES. Frank, L. A.; Ackerson, K. L. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Aug 1971. Contract NAS5-10625. 45p. (NASA-CR–124569). NTIS.

A local-time survey of the low-energy proton and electron intensities precipitated into the Earth's atmosphere during periods of magnetic quiescence was constructed. A typical, individual satellite crossing of this region in each of eight local-time sectors was selected from a library of similar observations with the polar-orbiting satellite Injun 5. The trapping boundary for more-energetic electron intensities, E > 45 keV, is a natural coordinate for delineating the boundary between the two major types of lower energy, 50 < or = E < or = 15,000 eV. The main contributors to electron energy influx are inverted-V precipitation poleward of the trapping boundary and the plasma-sheet intensities equatorward. These are interpreted in terms of a magnetospheric model. (auth) (STAR)

29006 RESULTS OF THE SCIENTIFIC RESEARCH PROGRAMME IN THE SPACE SCIENCE DEPARTMENT, ESTEC. Fitton, B.; Page, D. E.; Pedersen, A.; Taylor, B. G.; Trendelenburg, E. A. (European Space Research and Tech. Centre, Nordwijk, Netherlands). ELDO/ESRO Sci. Tech. Rev.; 3: No. 3, 321-426(1971).

The current research program and the results obtained in 1970 and during the beginning of 1971 are presented. They include the development of radiation detectors to be used in the magnetosphere, sounding rocket experiments, the development of a triggering telescope for high-energy cosmic gamma-ray detection, electric-field measurements from the GEOS satellite, laboratory studies on plasma simulation systems, surface problems arising in magnetospheric plasma measurements such as interference of photoemission, and secondary emission from the satellite surface. (France)

29007 OBSERVATIONS OF BURSTS, LINKED WITH THE SOLAR ACTIVITY, IN THE LOWER ATMOSPHERE (100mb). Blamont, Jacques; Pommereau, J. P. (CNRS, Verrieres-le-Buisson, France). Compt. Rend., Ser. B; 274: No. 3, 203-6 (17 Jan 1972). (In French).

The results of secondary cosmic-ray flux measurements made since 1967 in the lower stratosphere from balloons are presented. Short- and long-term bursts, which may be correlated with solar flares, were observed. In this way, the existence of fluctuations of solar origin were demonstrated for the first time in cosmic radiation of the lower stratosphere. (France)

29008 NATURE OF BALL LIGHTNING. Singer, Stanley. New York; Plenum Publishing Corporation (1971). 175p. $12.50.

Existing information, both theoretical and practical, on the nature of ball lightning is provided. Data compiled from observations, theories, and experimental studies, along with discussions of the old and new theories, are given. The nine chapters are entitled: Storm Lightning and Problem of Ball Lightning; Ball Lightning in the Prescientific Era; The Properties and Processes of Storm Lightning; The Question of the Existence of Ball Lightning; Observations of Ball Lightning; Photographs of Ball Lightning; Characteristics of Ball Lightning Derived from Observations; Theories and Experiments on Ball Lightning; and Present Aspect of the Ball Lightning Problem. (594 references)

29009 FORMATION OF CLUSTER IONS IN LABORATORY SOURCES AND IN THE IONOSPHERE. Narcisi, Rocco S. (Air Force Cambridge Research Labs., Bedford, Mass.). Advan. Electron. Electron Phys.; 29: 79-113(1970).

A study of ion–molecule reactions of fast reactions in gas discharges and in ion beams is presented for laboratory observations and the related observations of the ionosphere are discussed. Traces of water vapor provide a source of H and OH free radicals, which enter into chain reactions. Cluster ions that may be formed in the ionosphere and the corresponding laboratory observations are considered. The mass spectrometer was used for the analyses, but the ion cluster formation has been observed in a variety of sources. Results are given on the observations of water clusters around protons, NH_4^+, Na^+, NO^+, NO_2^+, O_2^+, O_2^-, O^-, OH^-, and halogen negative ions. Ions produced by α-particle bombardment of NH_3 were $NH_4^+ \cdot nNH_3$. A krypton resonance lamp was used to produce NO^+ in an afterglow cavity and clusters of $NO^+ \cdot nH_2O$ and $NO^+ \cdot NO$ were observed. Rocket-borne positive ion composition measurements in the D region at 50 to 90 km are reviewed, and E-region measurements are presented to show the distributions of atmospheric ion species at higher altitudes. Experimental techniques are described, rocket measurements are summarized, and ionospheric theories proposed to explain the D-region water-cluster ions are investigated. (19 figures, 44 references). (J.C.W.)

29010 ECLIPSED LOWER IONOSPHERE AS INVESTIGATED BY NATURAL VERY LOW FREQUENCY RADIO SIGNALS. Reeve, C. D.; Rycroft, M. J. (Univ. of Southampton, Eng.). J. Atmos. Terrest. Phys.; 34: No. 4, 667-72(Apr 1972).

Observations of naturally occurring vlf radio signals were made in Newfoundland during the solar eclipse of March 7, 1970. Some of the atmospherics received were tweeks, normally characteristic of night-time propagation conditions, each of which has a sharp low-frequency cutoff that gives information on the height of the ionospheric reflector. This varies from 69 km at the start of the eclipse to 76 km at maximum totality, and to 69 km at the end; these heights are somewhat less than those measured at totality by rocket methods, since the effects of the conical perturbation to the ionosphere are integrated over the propagation path from source to receiver. (auth)

29011 ELECTRON HEATING RATE AND ION CHEMISTRY IN THE THERMOSPHERE ABOVE WALLOPS ISLAND DURING THE SOLAR ECLIPSE OF 7 MARCH 1970. Brace, L. H. (Goddard Space Flight Center, Greenbelt, Md.); Mayr, H. G.; Pharo III, M. W.; (and others). J. Atmos. Terrest. Phys.; 34: No. 4, 673-88(Apr 1972).

An identical pair of thermosphere probes measured the N_2 concentration and temperature, the ion composition and concentrations, and the electron temperature up to 290 km about 30 min and 5 min before totality during the March 7, 1970 eclipse at Wallops Island. The rockets travelled similar trajectories thus permitting the purely temporal changes between flights to be resolved. The neutral temperature and N_2 concentration changed little but the electron temperature decreased by as much as 20% in the lower F region. The ion concentration decreased by about 30% in the F region and about 50% in the E region, with little change in relative ion composition. The electron cooling rates decreased by a factor of 6 in the lower F region, approximately in proportion to the change in visible solar disc. A smaller than expected decrease in the cooling rate below 150 km between the two flights indicates a hardening of the solar spectrum and suggests a significant heat contribution from the solar corona near totality. The ion composition measurements were consistent with solutions of the ion continuity equations. A proper fit required a factor of three enhancement of the flux below 200 Å, an amount also consistent with the electron heat balance analysis. Reactions involving the minor ions N^+ and N_2^+ were found to be important for the ion chemistry of the major ions O_2^+ and NO^+, especially at the time of eclipse. The negligible response of the neutral atmosphere to the eclipse is reasonable considering the long time constants for the conductive and convective transport processes and the local nature of the disturbance. (auth)

29012 ROCKET MEASUREMENTS OF CONJUGATE PHOTOELECTRONS DURING THE TOTAL SOLAR ECLIPSE OF 7 MARCH 1970 OVER WALLOPS ISLAND. Maier, E. J. (Goddard Space Flight Center, Greenbelt, Md.); Rao, B. C. Narasinga. J. Atmos. Terrest. Phys.; 34: No. 4, 689-94(Apr 1972).

Measurements made with a retarding potential analyzer on a Nike–Tomahawk rocket during the totality of the solar eclipse over Wallops Island, Virginia, showed definite evidence for the existence of photoelectrons from the conjugate hemisphere. Photoelectrons are observed in the altitude range of 120 to 260 km. The observed flux in the energy range of 2 to 30 eV is relatively constant above about 200 km, but decreased below that altitude. The flux of 5-eV electrons above 200-km altitude is about 10^7 el. cm^{-1} sec^{-1} eV^{-1}. Higher-energy electrons were also observed, and it is possible that the energy content of these observed fluxes of conjugate-point photoelectrons is sufficient to maintain the observed electron densities and temperatures during the total eclipse. (auth)

29013 IONOSPHERIC EFFECTS OF TWO RECENT SOLAR ECLIPSES. Marriott, R. T. (Univ. of California, Los Angeles); St. John, D. E.; Thorne, R. M.; Venkateswaran, S. V.; Mahadevan, P. J. Atmos. Terrest. Phys.; 34: No. 4, 695-712(Apr 1972).

Ionosonde observations and Faraday-rotation measurements of total electron content are used to study the effects observed in the E and F regions of the ionosphere during the total eclipse of March 7, 1970 and during the annular eclipse of September 11, 1969. The E-region effects are interpreted in terms of discrete ionization sources located over the photospheric disk and in the unocculted portions of the solar corona. The relative intensities of the individual sources are estimated. The bottomside F-region shows complex changes including the formation of an intermediate F1 layer during the March eclipse at medium latitude stations. Travelling ionospheric disturbances (TID's), some of which are probably eclipse-induced, are also observed. Analysis of the eclipse variations of electron density in the bottomside F region gives an electron production rate of about 1000 cm^{-3} sec^{-1} at a height of 300 km for the fairly active solar conditions of the March eclipse. The corresponding electron loss-coefficient β at this height is 8×10^{-4} sec^{-1}. Fractional reductions of about 30% are observed in the total electron content of the ionosphere during both the eclipses. Much of this reduction occurs in the topside ionosphere and is presumably accompanied by transport effects induced by the rapid cooling of the electron gas. (auth)

29014 NEUTRAL WINDS IMPLIED BY ELECTRON CONTENT OBSERVATIONS DURING THE 7 MARCH 1970 SOLAR ECLIPSE. Almeida, O. G.; Waldman, H.; Da Rosa, A. V. (Stanford Univ., Calif.). J. Atmos. Terrest. Phys.; 34: No. 4, 713-17(Apr 1972).

Measurements of columnar electron content using geostationary satellite signals were made at several observatories throughout the U.S., during the March 7, 1970 solar eclipse. The ionospheric response to the solar eclipse was simulated in a computer. Discrepancies between observed and simulated electron content behaviors can be greatly reduced by assuming the existence of plausible neutral winds originated by the eclipse in the F-region heights. (auth)

29015 IONOSPHERIC UNDULATIONS DURING THE SOLAR ECLIPSE OF 7 MARCH 1970. Arendt, P. R. (Inst. for Exploratory Research, Ft. Monmouth, N. J.). J. Atmos. Terrest. Phys.; 34: No. 4, 719-25(Apr 1972).

Traveling ionospheric disturbances predicted for a solar eclipse were observed at Ft. Monmouth, N.J. by means of total electron content measurements obtained from polarization data of the ATS-3 satellite beacon on 137.35 MHz. Magnetic storms prevailed during March 6–9, 1970. Thus unambiguous direct correlation of eclipse-produced internal waves with observed ionospheric effects is not possible. During the actual time of these eclipse observations, however, the magnetic disturbance was relatively low. Also the amplitude scintillation index of the ATS signals was low during that time. The automatically taken digitized polarization data yielded electron content variations with a precision of $\pm 3.5 \times 10^{11}$ electron/cm^2. Observed content undulations larger than these limits are considered real. They were compared with true-height variations of F-region plasma frequencies obtained from bottomside ionograms taken at Wallops Island. Deviations of the total content prior to local onset of the eclipse were not reflected by simultaneous undulations in the bottomside region. This picture changed after local onset of the eclipse, when content undulations appeared simultaneously with true-height variations during the early phase of the eclipse. It is concluded that undulations observed during that early phase can be ascribed to the predicted eclipse effects. The period of the content oscillations was found to be 18 ± 3 min. (auth)

29016 IONOSPHERIC HF DOPPLER DISPERSION DURING THE ECLIPSE OF 7 MARCH 1970 AND TID ANALYSIS. Sears, R. D. (Lockheed Palo Alto Research Lab., Calif.). J. Atmos. Terrest. Phys.; 34: No. 4, 727-32(Apr 1972).

The amplitudes and phases (relative to a local high-precision frequency standard) of WWV hf transmissions on 5, 10, and 15 MHz from Ft. Collins, Colorado, were recorded continuously during the period of the total solar eclipse on March 7, 1970. Changes in apparent Doppler frequency as small as 0.01 Hz could be detected. The goal of the experiment was to detect the passage of ionospheric acoustic-gravitational waves which were predicted by Chimonas and Hines (1970). Following a period of large phase and group path disturbance beginning at about 1600 UT, smaller phase path variations of a regular nature were observed after 1900 UT. Their periods, 25 min, correspond to the acoustic-gravitational wave period predicted by Chimonas (1970) for the solar eclipse-generated wave. The traveling ionospheric disturbances (TID) amplitude, ranging from 1 to 20% of the mean electron density at reflection height, was computed by combining the phase path data with group path data (Lerfald et al., 1970) and total electron content data (Davis and Da Rosa, 1970). Although the available data are suggestive, the TID which occurred after 1900 UT cannot be unequivocally associated with the ionospheric acoustic gravitational wave predicted by Chimonas and Hines (1970). (auth)

29017 TRAVELING IONOSPHERIC DISTURBANCES OBSERVED NEAR THE TIME OF THE SOLAR ECLIPSE OF 7 MARCH 1970. Lerfald, G. M. (Environmental Research Labs., Boulder, Colo.); Jurgens, R. B.; Vesecky, J. F.; Washburn, T. W. J. Atmos. Terrest. Phys.; 34: No. 4, 733-41(Apr 1972).

Experimental radio sounding data collected on March 7, 1970 were analyzed, with primary interest in detecting any traveling ionospheric disturbances generated by the solar eclipse of that day, as postulated by Chimonas and Hines (1970). Data from two oblique and three vertical incidence ionospheric sounders in the southwestern portion of the U.S.A. were used in the investigation. During the period 1600 to 1830 GMT, rather large-scale, wave-like disturbances traveled from north to south with apparent horizontal velocities of about 400 m/sec. The relationships between data from the several stations are fairly complex, perhaps as a result of interference effects between waves arriving from more than one source to the north. These disturbances occurred earlier than the expected arrival of any eclipse-generated effects and are believed related to the strong geomagnetic activity present on eclipse day. During the period 1930 to 2030 GMT, when an eclipse-generated disturbance could reasonably be expected to arrive, there is evidence of a traveling disturbance with a generally east-to-west component of motion. The apparent orientation of the wavefront differs by about 60 to 70° from that predicted by simple theory for a bow wave produced by the moving eclipse shadow. It is possible that propagation conditions for the traveling disturbance could cause departures from the concept

of a uniform, radially advancing wavefront; however, it is concluded that with the available data it is not possible to make a strong case for an eclipse associated effect. (auth)

29018 TWO TYPES OF INTERCONNECTION OF INTERPLANETARY MAGNETIC FORCE LINES WITH MAGNETOSPHERIC LINES AND THEIR RELATION WITH GEOMAGNETIC ACTIVITY. Bobrov, M. S. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 4, 496-503(Jul-Aug 1971).

Translated from Kosm. Issled.; 9: No. 4, 541-50(Jul-Aug 1971).

It has been found that an interconnection is possible not only with a southward direction of the interplanetary field ($\theta < 0$, the case considered by Dungey), but also with a northward direction of the field ($\theta > 0$). Whereas the case $\theta < 0$ favors the occurrence of polar substorms, on the other hand the case $\theta > 0$ inhibits their occurrence. In both cases there must occur injections of geoactive particles into the daytime sector of the polar ovals, that may be the cause of the daytime maximum in the permanent disturbances of the polar caps. The absence of a pronounced D_{st} at the time of activity only on the polar caps indicates that during a substorm the equatorial ring current becomes stronger, not because of "fresh" particles being injected into the daytime sector of the polar ovals, but because of particles entering from the plasma layer of the Earth's magnetic tail. (auth)

29019 INFLUENCE OF PENETRATING CHARGED PARTICLES ON READINGS OF SCINTILLATION DETECTORS IN THE MAGNETOSPHERE OF THE EARTH. Temnyi, V. V.; Polenov, B. V. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 4, 504-9(Jul-Aug 1971).

Translated from Kosm. Issled.; 9: No. 4, 551-7(Jul-Aug 1971).

Background readings of low-energy scintillation spectrometers RIÉ-204 (40 eV to 15 keV) are compared with the results of measurements received from a medium-energy spectrometer (20 keV to 150 keV and greater) and from geiger counters with a 4.5 g/cm^2 shield, installed in the "Kosmos-261" and the "Kosmos-348" satellites with circumpolar orbits. The composition of the background component is determined; specifically, the existence of a trapped electron flux with $E \geq 4$ MeV near $L = 3$ is verified, and estimates are obtained for the sensitivity of spectrometers RIÉ-204 to low-energy electrons in different regions of the magnetosphere, including the equatorial plane. (auth)

29020 CORPUSCULAR HYPOTHESIS OF THE IONIZATION OF THE D REGION OF THE IONOSPHERE IN CENTRAL LATITUDES. Bragin, Yu. A. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 4, 574-5(Jul-Aug 1971).

Translated from Kosm. Issled.; 9: No. 4, 625-6(Jul-Aug 1971).

The hypothesis of ionization of the D region by corpuscular fluxes resulted from an analysis of the altitude profiles of electron density n_e obtained by different methods, including rocket investigations. Some definite evidence based on direct measurements of the intensity I of the corpuscular fluxes and the concentration of ions, e.g., positive ions (n^+) in the lower atmosphere at central latitudes comes from that obtained in the USSR by a team from the Central Aerological Observatory. An analysis of rocket measurements of positive-ion density showed that a relatively high number of charged particles could be maintained at a height of 60 to 90 km by day and night by a fairly strong ionizing agent acting for 24 hours. Such an agent could be corpuscular fluxes with intensities 10 to 10^3 cm^{-2} sec^{-1} for electrons with energies of approximately 10^5 eV, and 1 to 10^3 cm^{-2} sec^{-1} for protons with energies of the order of 10^7 eV. The presence of a large number of negative ions at the considered heights by day and night allows observed changes in n_e below 80 km to be attributed to photodetachment of electrons from negative ions, i.e., ionization of neutral air by photons below 80 km need not be responsible for formation of the n_e profile. (J.C.W.)

29021 RESPONSE OF THE NEUTRAL PARTICLE UPPER ATMOSPHERE TO THE SOLAR ECLIPSE OF 7 MARCH 1970. Horvath, J. J. (Univ. of Michigan, Ann Arbor); Theon, J. S. J. Atmos. Terrest. Phys.; 34: No. 4, 593-9(Apr 1972).

A series of five pitot probes were launched from Wallops Island, Va. (38°N) in conjunction with the solar eclipse, March 7, 1970. Three soundings were programmed to occur at 40, 80, and 100% obscuration of the Sun (at 100 km) during a 42-min period. The remaining two soundings were made 24 hr before and after the eclipse. The five soundings yielded neutral particle pressure, temperature, and density profiles over the altitude regime 30 to 125 km. Below 95 km, the three density profiles resulting from the eclipse day launches has an average deviation of less than 1.5%; above 95 km, density changes of up to 20% were observed. Such changes in density are comparable in magnitude to those normally observed over a period of several hours. On March 10, 1971, three additional pitot probes were launched from Wallops Island, Va. at times identical to those of the 1970 eclipse day. Comparison of the two sets of data should provide for a more objective analysis regarding atmospheric response to solar input. (auth)

29022 IONIZATION CHANGES IN THE LOWER IONOSPHERE DURING THE SOLAR ECLIPSE OF 7 MARCH 1970. Belrose, J. S. (Communications Research Centre, Ottawa); Ross, D. B.; McNamara, A. G. J. Atmos. Terrest. Phys.; 34: No. 4, 627-40(Apr 1972).

Measurements in the lower ionosphere (65 to 150 km) of 2.66-MHz differential absorption and of Langmuir probe currents were obtained using four rockets launched in Nova Scotia, Canada during the March 7, 1970 solar eclipse. It was found that the eclipse caused a maximum decrease in the electron number density by more than a factor of 10 below 80 km, but by only 3 to 5 above 85 km. Below 80 km, the smallest densities were observed on the third flight, 7 to 20 s after 3rd contact, and the D-region ledge between 65 and 75 km had disappeared. On the last flight, 360 s later, this ledge had begun to redevelop; however, the lowest densities in the 85 to 90 km and 125 to 150 km ranges were observed on this flight. Densities of about 60 electrons cm^{-3} at 80 km, 700 at 85, 7000 at 95, and 30,000 above 105 km were the minimum ones recorded. The paper compares these electron number densities to those measured at night by other experiments. The height dependence of the rate of disappearance of electrons leads to values of the effective recombination coefficient which decrease from about 10^{-4} cm^3 s^{-1} at 80 km to 3×10^{-7} cm^3 s^{-1} at 95 km and indicates an increase in the ratio of negative ions to electrons below about 80 km. (auth)

29023 ELECTRON LOSS COEFFICIENTS FOR THE D-REGION OF THE IONOSPHERE FROM ROCKET MEASUREMENTS DURING THE ECLIPSES OF MARCH 1970 AND NOVEMBER 1966. Mechtly, E. A. (Univ. of Illinois, Urbana); Sechrist, C. F. Jr.; Smith, L. G. J. Atmos. Terrest. Phys.; 34: No. 4, 641-6(Apr 1972).

Recombination-like electron loss coefficients measured during the March 1970 eclipse coincide with those from the November 1966 eclipse and range from 2×10^{-7} cm^3 s^{-1} at $Z_0 + 6$ km to 5×10^{-5} cm^3 s^{-1} at $Z_0 - 2$ km, where Z_0 is the altitude of the steep gradient of electron concentration. During totality; Z_0 was 82.5 km in 1970, and 86.8 km in 1966. For full-Sun conditions, Z_0 was 84 km on both eclipse days. Attachment-like electron loss coefficients from both eclipses are in good agreement below Z_0 and have a nearly constant value of about 8×10^{-3} s^{-1}. Below Z_0, attachment-like loss rates agree with production rates, i.e., electron concentration is proportional to electron production. (auth)

29024 ECLIPSE ROCKET MEASUREMENTS OF CHARGED PARTICLE CONCENTRATIONS. Ulwick, J. C. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Atmos. Terrest. Phys.; 34: No. 4, 659-65(Apr 1972).

Rocket probe measurements were made of charged-particle concentrations during the November 12, 1966 eclipse at Cassino, Brazil at totality and at 80% solar obscuration before and after totality. A week prior to the eclipse totality, a rocket was flown to provide payload certification and background measurements. The results show that the electron densities obtained prior to (T − 16.1 min) and after (T + 12.3 min) totality agree quite well and are about a factor of 5 less than background results in the altitude range 70 to 87 km. During totality, the ion and electron densities are about the same above about 88 km but below this altitude the electron density drops sharply to about 10^2 electrons per cm^3 while the positive ion density remains at about 10^3 ions per cm^3. The results are compared to other rocket measurements during this eclipse. (auth)

29025 COUPLED RESONANCES OF HYDROMAGNETIC WAVES IN A COLD PLASMA. Radoski, Henry R. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geomagnet. Geoelec.; 23: No. 1, 83-99(1971).

In the magnetosphere, the two basic hydromagnetic modes, the isotropic or poloidal and the guided or toroidal, must always be coupled. This problem of coupled propagation must be solved before long-period magnetic variations can be explained or utilized. The problem has added interest since the two modes are so dissimilar and the toroidal mode is peculiar by itself. Mode coupling was studied for the very useful model of the MHD wedge. This geometry has the virtue that it avoids cumbersome mathematical formalism and yet retains the essential physical difficulty inherent in the magnetospheric problem to which the results may be applied. Among the steady-state solutions, to be presented, are a distinctive type in which the eigenmodes can exist only in prescribed regions of the system. The eigenperiods themselves aid in determining the

limits of the system to which they apply. This unusual behavior is associated with oscillating sheet currents on field line shells of a particular characteristic period, which reflect waves of the same period. Such a phenomenon may give rise to ducting of definite bands of frequencies of hydromagnetic waves. It also poses several important problems in excitation, growth and dissipation of the wave energy. (auth)

29026 EARTH ALBEDO NEUTRONS FROM 10 TO 100 MeV. Preszler, Alan M.; Simnett, George M.; White, R. Stephen (Univ. of California, Riverside). Phys. Rev. Lett.; 28: No. 15, 982-5(10 Apr 1972).

The energy and angular distributions of Earth-albedo neutrons from 10 to 100 MeV at 40°N geomagnetic latitude were measured from a balloon at 120,000 ft, below 4.65 g/cm^2. The albedo-neutron omnidirectional energy distribution is flat to 50 MeV, then decreases with energy. The absolute neutron energy distribution is of the correct strength and shape for the albedo neutrons to be the source of the protons trapped in Earth's inner radiation belt. (auth)

29027 MIDLATITUDE ELECTRON DENSITY PROFILE IN THE LOW SOLAR ACTIVITY. Maeda, Ken-ichi (Kyoto Univ.). J. Geomagnet. Geoelec.; 22: No. 4, 551-7(1970).

The data on electron density at midlatitude regions and at low solar activity were used from all available measurements to study the electron density profile from 50 to 200 km at 2.5-km intervals. A summary is given for seasonal, daytime, and nighttime profiles. (J.C.W.)

29028 NEGATIVE ION DENSITIES IN CHEMICAL EQUILIBRIUM IN THE D REGION. Kamiyama, Hiroshi (Tohoku Univ., Sendai). J. Geomagnet. Geoelec.; 22: No. 4, 403-11(1970).

From an assumption of the distributions of minor constituents in the upper mesosphere, an estimate was made of the negative-ion densities in chemical equilibrium with the observed electron density. The result shows that the negative ion composition in the region above 80 km is essentially the same as in the E region. But in the region below 70 km, negative ions, such as CO_3^-, NO_2^-, and NO_3^-, of high electron affinities are shown to be relatively abundant, especially during the night. The result may possibly account for the characteristic growth of the D-region electron density at sunrise. A discussion of the sequences of negative ions in the D region leads to the conclusion that O_3 and CO_2 play an important role in determining the abundance of these negative ions of high electron affinities. (auth)

29029 NOTE ON THE HEIGHT OF THE GEOMAGNETIC Sq CURRENT. Volland, H. (Univ., Bonn). J. Geomagnet. Geoelec.; 23: No. 1, 117-21(1971).

Rocket-borne measurements determined a height of the Sq current near 115-km altitude at midlatitudes. It is suggested that this height is only a secondary maximum of the Sq current related to the Hall component of the current. (auth)

29030 ^{14}C DATA AND THE LASCHAMP REVERSED EVENT. Grey, Donald C. (Univ. of Utah, Salt Lake City). J. Geomagnet. Geoelec.; 23: No. 1, 123-7(1971).

A model by Cox (Science, 63: 237(1969)) presents the behavior of the Earth's magnetic field as a steady-state oscillation with a period of the order of 10^4 years, an amplitude of about half the present strength, and with aperiodic reversals triggered by stochastic events that coincide with minima of the steady-state oscillation. Data of Bucha and Neustupny (1967) indicate the presence of such a steady-state oscillation in recent time, while the studies of the Steens Mountain flows by Baksi, et al. (1967) indicate the presence of such an oscillation with an accompanying reversal around 15 million years ago. A survey of the available research made on the Laschamp reversed-polarity event is reviewed using the carbon-14 data on the concentration in the Earth system. The model presented assumed that field variations do indeed follow the pattern suggested by Cox. Since ^{14}C production depends upon the strength, but not the polarity, of the geomagnetic field, an excursion of the field near zero, but without reversal, would produce the same effect as a reversal. It was assumed that the reversal that introduced the Laschamp event was sufficiently early so that its effect on the ^{14}C inventory is negligible at the time of the terminating reversal. (J.C.W.)

29031 STUDY ON ELECTRON DENSITY PROFILE IN THE LOWER IONOSPHERE. Maeda, Ken-ichi (Kyoto Univ.). J. Geomagnet. Geoelec.; 23: No. 2, 133-59(1971).

The daytime N(h) profiles in the E and D regions are obtained for summer, spring and fall, and winter, based on data available from rocket experiments. The profiles cover the periods of low, medium, and high solar activity. The N_{max} in the normal E region obtained by routine ionosonde observation is studied to compare with the rocket data and to obtain the solar activity dependence of N_{max} or Φ_0, the solar photon flux density at λ = 1025.7 and 977 Å, which controls the N_{max} in the E region. From the satellite observation of the solar x-ray flux at λ = 1 to 8 Å, the solar-activity dependence of the x-ray flux, which controls the ionization at the lower part of the E region, is tentatively estimated. Based on the result of the above study the N(h) profiles are calculated, following the current theory of the E-region formation, for each case of the observed N(h) profiles as described above. Fairly good agreement is found between the theory and experiment. Thus we can know the N(h) profile for any season in any solar activity. Some nighttime profiles are studied from rocket data and the nocturnal variation of the N(h) in the E region is obtained. Based on this result the electron production rate of geocorona, a possible nighttime source of ionization, and the effective recombination coefficient are estimated. Finally the N(h) profile during winter absorption anomaly is calculated, based on some atmospheric temperature models, which are available from actual rocket observations. It is found that the E layer comes down and this enables one to interpret the lowering of the reflection height of the Loran waves during anomaly reported by other workers. (59 references). (auth)

29032 SOLAR-CYCLE EFFECTS IN ELECTRON DRIFTS OVER THE MAGNETIC EQUATOR. Misra, R. K.; Chandra, H.; Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). J. Geomagnet. Geoelec.; 23: No. 2, 181-6(1971).

The E- and F-region apparent and true drifts over the equatorial station Thumba are studied for the period 1964–69 in relation to the solar activity. The apparent drift is found to reduce slightly while the true drift is reduced considerably, with the increasing solar activity. This result is interpreted by comparing the sensitivity factors for N_e and the solar daily range R_H of the Earth's magnetic field. (auth)

Effects of Nuclear Detonations

29033 (AD-733334) APPLICATION OF A LIMIT ON STABLY TRAPPED ELECTRON FLUX. Report for March–May 1971. Schulz, Michael (Aerospace Corp., El Segundo, Calif.). 15 Sep 1971. Contract F04701-71-C-0172. 24p. (SAMSO-TR-71-265). NTIS.

From the viewpoint of satellite survivability, self-generated whistler-mode noise significantly limits the flux of relativistic electrons that can be injected into stable radiation belts by nuclear detonations. (auth) (NTIS)

29034 VARIATION OF RAYLEIGH-WAVE AMPLITUDE WITH YIELD AND HEIGHT OF BURST FOR INTERMEDIATE-ALTITUDE NUCLEAR DETONATIONS. Murphy, Brian L. (Mt. Auburn Research Associates, Inc., Newton, Mass.). J. Geophys. Res.; 77: No. 5, 808-17(10 Feb 1972).

The source strength for far-field Rayleigh-wave excitation is calculated as a function of yield and height of burst for intermediate-altitude nuclear detonations (height of burst approximately 20 to 100 km). In general the source strength, and hence the far-field Rayleigh-wave amplitude, has a maximum (for a given yield) at a particular burst height. The altitude at which the maximum occurs depends on the detonation yield and on the Rayleigh-wave period under consideration. The maximum is more pronounced for the longer Rayleigh-wave periods. For intermediate-altitude detonations, the variation of far-field Rayleigh-wave amplitude with yield is found to lie between the $\frac{1}{2}$ and $\frac{2}{3}$ power of the yield, depending on the burst altitude and on the Rayleigh-wave period being considered. (auth)

29035 MEASUREMENTS OF RADIATION EFFECTS OF THE THERMONUCLEAR EXPLOSION IN THE CHINESE PEOPLE'S REPUBLIC ON DECEMBER 27, 1968 BY KOSMOS-259 AND KOSMOS-262. Shafer, Yu. G.; Kozlov, V. I.; Kirienko, I. S.; (and others). Cosmic Res. (USSR) (Engl. Transl.); 9: No. 4, 510-15(Jul-Aug 1971).

Translated from Kosm. Issled.; 9: No. 4, 558-64(Jul-Aug 1971).

Results of measurements of the hard radiation due to the nuclear explosion in the Chinese People's Republic are given. Two possible mechanisms by which the explosion might disturb the particles in the natural radiation belts are discussed. One of them is the transport of trapped radiation by a single induced electromagnetic pulse due to the sudden expansion of the explosion plasma in the geomagnetic field. In the second mechanism the natural oscillations of the magnetosphere ($\omega \sim 0.1 - 0.01$ Hz) build up, as in a resonant cavity, after the "crack" of the explosion through the magnetosphere. The oscillations act on trapped radiation particles with frequencies (τ_φ^{-1}) that are in resonance with them. This might lead to displacement followed by adiabatic acceleration of high-energy (E ~ 100 MeV) protons from the L ≈ 2 shell ($\tau_\varphi^{-1} \sim 0.1$ Hz), which might be

responsible for the detection of protons with E ≳ 190 MeV in the case of the explosion in China. (auth)

29036 POSSIBLE MECHANISM OF LOCALIZATION OF FISSION FRAGMENTS FROM A HIGH-ALTITUDE THERMONUCLEAR EXPLOSION. Kozlov, V. I.; Shafer, Yu. G. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 4, 580-1(Jul-Aug 1971). Translated from Kosm. Issled.; 9: No. 4, 630-1(Jul-Aug 1971).

A possible mechanism of localization of fission fragments in the magnetic conjugate region is a magnetogravitational trap, which for heavy charged fission fragments is a potential well, and a generalized potential is given. Explosion products remain a long time at high altitudes in the magnetic conjugate region of the site of the explosion. An example is given for a heavy fragment with atomic weight A = 100, h = 400 km, and the energy is calculated to be about 30 eV, and it is captured in the magnetogravitational trap. The spatial distribution of the heavy ions trapped in the potential well will follow the configuration of the inhomogeneous geomagnetic field and will be funnel-shaped. Calculations show that as the magnetically conjugate region, situated at the base of the funnel, loses ions into the loss cone, it is continuously replenished by particles from the higher regions of the funnel. As estimates of the drift velocity show, smearing of the funnel due to the drift of heavy ions with energy ~30 eV captured in the magnetogravitational trap is insignificant. This is underlined by the experimental fact that the trapped fission fragments are a fairly compact source of β and γ rays from the geomagnetic viewpoint. (J.C.W.)

Particle Kinetics and Trapping

Refer also to abstract 28138.

29037 (AD-733336) PATTERNS AND SOURCES OF HIGH-LATITUDE PARTICLE PRECIPITATION. Report for June 1970-January 1971. Paulikas, George A. (Aerospace Corp., El Segundo, Calif.). 1 Nov 1971. Contract F04701-71-C-0172. 121p. (SAMSO-TR-71-269). NTIS.

Properties of the zones of particle precipitation at high latitudes are surveyed, and the average properties of particle influx from the outer magnetosphere as determined by satellite and rocket observations as well as ground-based techniques are considered. An attempt is made to associate source regions, and, if possible, precipitation mechanisms with each of the families of precipitating particles that collectively form the auroral zone. The precipitation patterns for both electrons and protons exhibit a diurnal variation. The several zones of particle precipitation can be placed in relationship to each other. The zone of electron precipitation is best described as consisting of a region at low latitudes where electrons with characteristic energies of tens of keV precipitate; this region merges and overlaps at the higher latitudes with another region characterized by precipitating electrons of about 0.5 keV. The limited data available indicate that the zone of proton precipitation spatially overlaps the zone of electron precipitation. The plasma sheet, the extraterrestrial ring current, the polar cusp, and the outer radiation belt are considered as source regions of precipitating particles. Brief surveys of the precipitation of helium ions and of possible means of artificially inducing particle precipitation are also included. (auth) (NTIS)

29038 (AD-733474) CHANGES IN MAGNETOSPHERIC CONFIGURATION DURING SUBSTORM GROWTH PHASE. Coroniti, Ferdinand V.; Kennel, Charles F. (California Univ., Los Angeles. Plasma Physics Group). Nov 1971. Contract N00014-69-A-0200-4023. 37p. (PPG-102). NTIS.

Four simple calculations suggest that the magnetosphere changes its configuration during substorm growth phase. A flaring-tail model indicates that the observed increases in geomagnetic tail field can only be explained if the dayside magnetopause shrinks by 1 to $2R_E$. The same assumption is needed to explain large magnetic decreases observed at geostationary orbit. A plasma-sheet model, consistent with a flaring tail, indicates that increased tail flaring leads to plasma sheet thinning, and a decrease in northward magnetic field, during substorm growth phase. The motion of the inner edge of the plasma sheet, and consequently an equatorward shift of the nightside auroral oval, is consistent with the above structural modifications. (auth) (NTIS)

29039 (AD-733717) DRIFT-SHELL SPLITTING AT ARBITRARY PITCH NOISE. Schulz, Michael (Aerospace Corp., El Segundo, Calif.). 15 Nov 1971. Contract F04701-71-C-0172. 37p. (SAMSO-TR-71-256). NTIS.

Analytical expressions are developed to approximate the bounce period and second invariant as functions of particle energy, equatorial pitch angle, and parameters of the guiding field line. The equatorial pitch angle is not restricted to values near pi/2, as in the harmonic-oscillator approximation, but terms indicating deviation of the magnetic field from that of a dipole are included to first order only. There follow approximate analytical expressions for tracing drift shells in the magnetosphere. Two important cases are considered separately: (a) shell splitting caused by dawn-dusk asymmetry of the magnetosphere's electrostatic potential, superimposed on a dipolar magnetic field, and (b) shell splitting caused by day-night asymmetry of the Earth's magnetic field in the absence of electric fields. In each case an expression is derived for the relationship between pitch-angle diffusion and radial diffusion in the presence of drift-shell splitting at arbitrary equatorial pitch angle. (auth) (NTIS)

29040 (AD-734034) THERMALIZATION OF COLLIDING ION STREAMS BEYOND THE PLASMAPAUSE. Report for October 1970-May 1971. Schulz, Michael; Koons, Harry C. (Aerospace Corp., El Segundo, Calif.). 15 Sep 1971. Contract F04701-71-C-0172. 26p. (SAMSO-TR-71-266). NTIS.

On field lines that are closed, oppositely directed plasma flows analogous to the polar wind can originate from conjugate regions of the ionosphere and encounter each other near the equatorial plane. For a background plasma of sufficiently low equatorial density ($N_0 \leq 20/cm^3$), thermalization of the two streams can occur through the excitation of unstable ion waves. At higher densities ($N_0 \geq 20/cm^3$) thermalization occurs via Coulomb collision. These flows, together with the complementary thermalization mechanisms, constitute a rapid means of replenishing the plasmasphere (dN_0/dt about $10/cm^3$ hr) during the recovery phase of a magnetic storm. Beyond the quiet-day plasmapause location, the conditions for two-stream instability appear to be present continuously, since the counter-streaming plasmas are simultaneously convected to the magnetospheric boundary. (auth) (NTIS)

29041 (N-71-38546) VAN ALLEN BELT RADIATION ON TIROS/TOS/ITOS SPACECRAFTS. Stassinopoulos, E. G. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Sep 1971. 50p. (NASA-TM-X-65717; X-641-71-413). NTIS.

Calculations proposed for the two Tiros orbits are summarized for electrons and protons. The superimposed spectral distribution for the two trajectories is given graphically for each type of particle, and a selected set of integral energies is plotted versus altitude for electrons and protons. Finally, for each of the two flight paths two computer plots are included, depicting the characteristic averaged instantaneous intensities of the trajectory in terms of constant L bands of 0.1 Earth-radius width and the percent of total lifetime spent in each L interval. (STAR)

29042 (N-72-12326) CHARACTERISTICS OF MAGNETOSHEATH PLASMA OBSERVED AT LOW ALTITUDES IN THE DAYSIDE MAGNETOSPHERIC CUSPS. Winningham, J. David (Texas Univ., Dallas). 7 Jul 1971. Contract NAS5-9112. 26p. (NASA-CR-122301). NTIS.

Magnetosheath plasma penetrating to low altitudes in the dayside cusp region of the magnetosphere was observed by the ISIS-1 soft-particle spectrometer (SPS). The extent of these particle fluxes in local magnetic time and invariant latitude, their variation with magnetic activity, and their pitch-angle distribution are given. Comparison between the SPS data and energetic-particle data indicates that the boundary between open and closed field lines on the dayside is associated with a sharp drop in the outer-zone > keV electron fluxes. It is shown that these newly identified cusp fluxes provide the necessary energy to produce observed dayside auroral oval phenomena. (auth) (STAR)

29043 (N-72-12742) INJUN 5 OBSERVATIONS OF MAGNETOSPHERIC ELECTRIC FIELDS AND PLASMA CONVECTION. Gurnett, Donald A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Sep 1971. Contract NAS5-10625. 33p. (NASA-CR-124544). NTIS.

Recent measurements of magnetospheric electric fields with the satellite Injun 5 have provided a comprehensive global survey of plasma convection at low altitudes in the magnetosphere. A persistent feature of these electric-field observations is the occurrence of an abrupt reversal in the convection electric field at auroral-zone latitudes. The plasma convection velocities associated with these reversals are generally directed east-west, away from the Sun on the poleward side of the reversal, and toward the Sun on the equatorward side of the reversal. Convection velocities over the polar-cap region are normally less than those observed near the reversal region. The electric-field reversal is observed to be coincident with the trapping boundary for electrons with energies E > 45 keV. (auth) (STAR)

29044 COMPOSITION OF FAST CHARGED PARTICLES IN THE INNER RADIATION BELT. Gorchakov, E. V.; Ternov-

skaya, M. V. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 4, 571-3(Jul-Aug 1971).

Translated from Kosm. Issled.; 9: No. 4, 622-4(Jul-Aug 1971).

It was reported earlier (Kosm. Issled., 7: 273(1969)) that measurements made on Kosmos 137 differed somewhat from those previously made on Explorer 11 of fast charged particles in the inner radiation belt. Kosmos 137 was launched on Dec. 21, 1966 and, with a Cherenkov detector, protons with energy $\gtrsim$ 600 MeV and electrons with energy $\gtrsim$ 7 MeV (threshold I) and protons with energy $\gtrsim$ 1 BeV and electrons with energy $\gtrsim$ 15 MeV (threshold III) were observed. The difference noted from the Explorer-11 observations can probably be attributed to energetic electrons of artificial origin left in the inner radiation belt from the 1966 thermonuclear explosion. Further investigation of the data shows that the particle spectrum has a special feature close to L = 1.35, and on this magnetic shell at a fixed value of B the ratio of the threshold I and III readings is a maximum, and on smaller and larger L the ratio of the channel I and III counting rates is lower. This effect on magnetic shell close to L $\approx$ 1.35 can be attributed to the presence of a considerable number of electrons with energy 7 to 15 MeV on these shells or to softening of the spectrum of energetic protons on magnetic shells close to L = 1.35. It is generally accepted that inner-belt protons with energy of several hundred MeV or more are produced by the neutron mechanism. It is concluded that with the adopted assumptions the experimentally obtained relaxation time of artificially injected electrons, estimated at about 6 to 8 months, agrees satisfactorily with relaxation time determined by Coulomb losses. (J.C.W.)

29045 INTERACTION BETWEEN HYDROMAGNETIC OSCILLATIONS AND MAGNETOSPHERIC CONVECTIONS. Namikawa, T.; Matsushita, S. (High Altitude Observatory , Boulder Colo.). J. Geomagnet. Geoelec.; 23: No. 1, 107-10(1971).

An interpretation of damped-type geomagnetic pulsations associated with geomagnetic storms was made by the authors (Planet. Space Sci., 18: 407(1970)) as an interaction between hydromagnetic oscillations and magnetospheric motions caused by solar winds. A modified model is given here showing that, at the time of a sudden commencement (sc), the magnetosphere is compressed because of the density increase along the stream line. The shear strain rate shows the shape variations, and the normal strain rate represents the volume variations of a fluid mass. At the time of sc, the shape variation of the magnetosphere is larger than the volume variation; therefore, growing oscillations are present. Hydromagnetic pulsations are excited during this stage of geomagnetic storms. When the storm-time solar wind covers all of the magnetosphere, the shape variation of the magnetosphere does not exist and only the volume variation remains. Further analysis of the models is given. (J.C.W.)

29046 PERIODS OF THE MAGNETOSPHERIC OSCILLATIONS AND THE PLASMA DENSITY. Namgaladze, A. A. (Kaliningrad Magnetic and Ionospheric Observatory, USSR); Brunelli, B. E. J. Geomagnet. Geoelec.; 22: No. 4, 383-91(1970).

Periods of self-oscillation of the magnetosphere were calculated for the cases of weak or strong dependence of its amplitude on longitude, using a Mead-type model. It is shown that the transverse wave can exist when the periods of these two modes are equal. This condition is satisfied at latitudes near the auroral zone. The oscillations with a longitudinal dependence in Gauss-function form are also considered, and the values of N_e/T^2 are calculated. The plasma density, N_e in the magnetosphere is estimated using the period T of observed geomagnetic pulsations; the result is in agreement with the data of other methods. (auth)

29047 TRANSIENT MICROPULSATION SIGNALS. Rankin, D.; Jacobs, J. A. (Univ. of Alberta, Edmonton). J. Geomagnet. Geoelec.; 22: No. 4, 413-19(1970).

During extremely quiet magnetic times, transient magnetic signals were observed that differ significantly from any previously reported. They can be interpreted as being due to a traveling bunch of charged particles (for which two models are discussed), or to meteors. (auth)

29048 CHARACTERISTICS OF DISPERSION AND OCCURRENCE RATE OF WHISTLERS AT LOW LATITUDES DURING ONE SOLAR CYCLE. Hayakawa, Masashi; Ohtsu, Jinsuke; Iwai, Akira (Nagoya Univ., Toyakawa, Japan). J. Geomagnet. Geoelec.; 23: No. 2, 187-204(1971).

Electron-density variations in the magnetosphere at a geocentric distance of ~1.50 Earth radii are deduced from whistler dispersion data during one solar cycle from the year 1958 to 1968. It was found that the magnetosphere shows less sensitivity to the long-term variation of solar activity than does the ionosphere. Also, the variation of whistler dispersion at low latitude shows a semi-annual change, which will be discussed in comparison with the ionospheric f_0F2 variation. Moreover, the characteristics of occurrence rate of low-latitude whistlers are investigated with special reference to the solar-cycle and annual variations. These features on occurrence rate are explained in terms of ionospheric absorption and duct formation. (auth)

29049 ACCELERATION OF CHARGED PARTICLES IN THE NEUTRAL SHEET. Mukai, Tadashi (Kyoto Univ.). J. Geomagnet. Geoelec.; 23: No. 2, 225-33(1971).

The plasma that flows into the contact region of two sunspots of opposite polarity (which is named "the neutral sheet") induces an electric field. This induced electric field can accelerate a part of the charged particles. It is shown that the charged particle can reach an energy of a few MeV within a time less than one second. By comparing the energy gain from the induced electric field with the energy loss by the surrounding matter, it is shown that 0.046% of the surrounding protons in the neutral sheet can be accelerated to the high energy at kinetic temperature $T_0 = 10^5$ °K and density $N = 10^{12}$ cm^{-3} of the surrounding matter. (auth)

Solar Wind and Cosmic Ray Interactions

Refer also to abstracts 29032 and 29048.

29050 (AD-732469) RELATIONSHIPS BETWEEN SOLAR FLARES AND OTHER ASPECTS OF SOLAR ACTIVITY. Final Report, October 1, 1966-September 30, 1971. Mohler, Orren C. (Michigan Univ., Ann Arbor. Dept. of Astronomy). Nov 1971. Contract N00014-67-A-0181-0001. 11p. NTIS.

The review of the relationships between solar flares and other aspects of solar activity is centered around three principal projects: (1) the relationship aspects of solar activity between daily 2800-MHz flux and the number of flares per day; (2) re-examination of solar circumstances prior to each geomagnetic storm since 1955; and (3) systematic study of all centers of activity since 1955. (auth) (NTIS)

29051 (N-72-12804) ELECTROSTATIC SHORT-WAVELENGTH TURBULENCE AS SOURCE OF ION HEATING IN THE SOLAR WIND. Papadopoulis, Konstantinos (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). [1971]. 19p. (NASA-CR-123477). NTIS.

A mechanism is proposed for the nonthermal ion heating observed in the solar wind at 1 A.U. based on an electrostatic, short-wavelength, instability between the ions in the observed colliding plasma streams. The modes lying on a plane perpendicular to the magnetic field thermalize most of the differential energy. The model suggests local electrostatic turbulence, that alpha particles are heated more than protons, a maximum proton temperature $T_p < 10^6$ K, and for the bulk speed U, possibly a $\sqrt{T_p} = aU + b$ relationship. These predictions are consistent with observations. (auth) (STAR)

29052 KOSMICHESKIE LUCHI V MAGNITNOM POLE ZEMLI. (Cosmic Rays in the Earth's Magnetic Field). Dorman, L. I.; Smirnov, V. S.; Tyasto, M. I. Moscow; Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury (1971). 400p.

The influence of a constant magnetic field on cosmic rays and an analysis of their trajectory are considered. The effect of a fluctuating geomagnetic field, magnetic storms, and penumbras on cosmic rays is discussed. Successive chapters are devoted to unsymmetric perturbations of the magnetosphere, effects of filiform current rings, extra-ionospheric systems of currents, and current shells. (K.S.W.)

29053 MODEL FOR THE INTERACTION OF THE SOLAR WIND WITH THE INTERSTELLAR MEDIUM. Baranov, V. B.; Krasnobaev, K. V. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 4, 568-70(Jul-Aug 1971).

Translated from Kosm. Issled.; 9: No. 4, 620-2(Jul-Aug 1971).

A model is proposed for the interaction of the solar wind with the interstellar medium, assuming that there is a magnetic field in the interstellar medium. The general flow pattern is shown in a coordinate system moving with the center of the Sun. The outer shock wave (whose formation is analogous to shock-wave formation near a solid in a supersonic flow of a rather dense gas) weakens at its wings and degenerates into a characteristic. The inner shock wave, which arises in the solar wind because of its damping by the interstellar medium, closes into an oval since the solar-wind velocity is much greater than the velocity of the solar system with respect to the interstellar gas. (J.C.W.)

29054 ION COMPOSITION MEASUREMENTS IN THE LOWER IONOSPHERE DURING THE NOVEMBER 1966 AND MARCH 1970 SOLAR ECLIPSES. Narcisi, R. S.; Bailey, A. D.; Wlodyka, L. E.; Philbrick, C. R. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Atmos. Terrest. Phys.; 34: No. 4, 647-58(Apr 1972).

Positive ion composition measurements in the D and lower E regions were performed on three rocket flights during the November 1966 solar eclipse program conducted at Cassino, Brazil. Progressing into totality, the E region results showed that NO^+ and O_2^+ decreased in concentration while the ratio NO^+/O_2^+ increased. Long-lived meteoric atomic ions appeared to be unaffected within the short period of the eclipse. A meteoric ion layer that was submerged prior to totality, became prominent as the molecular ions decayed and produced a sporadic E layer at 105 km near totality. The D-region results provided evidence for the existence of a fast process for the conversion of NO^+ to water cluster ions. The decrease in water cluster ion concentration at totality was probably less than a factor of four in the vicinity of 80 km. Negative ion composition measurements were obtained over Wallops Island, Virginia between 70 and 111 km close to totality of the March 7, 1970 solar eclipse. Heavy negative cluster ions were predominant below 92 km and were restricted to below this altitude. Between 90 and 98 km, and only on rocket descent, there were relatively large concentrations of ions with masses near 16, 32, 46, and 62 amu, probably O^-, O_2^-, NO_2^- and NO_3^-. Such large concentrations were not measured in earlier flights in the undisturbed ionosphere and cannot be explained with presently known processes. (auth)

29055 SOLAR-WIND-ASSOCIATED COMPONENT IN THE LOW-LATITUDE MAGNETIC DAILY VARIATION. Bhargava, B. N.; Yacob, A. (Indian Inst. of Geomagnetism, Bombay). J. Geomagnet. Geoelec.; 23: No. 2, 249-53(1971).

Evidence is presented for an appreciable solar-wind-associated component in the low-latitude diurnal variation under magnetic conditions of absolute calm to those of slight-to-moderate disturbance and to show that it causes an evening-side depression in this field. Data were used from an extensive series of mean daily horizontal intensity measurements at Alibag over a period of 37 years, beginning Jan. 1, 1932. Amplitude and phase, under relatively quiet conditions, of the wind-associated component were computed from diurnal variations of the horizontal intensity on days of exceptional calm (Ap = 0), calm (Ap ~5), slight disturbance (Ap ~ 10), and moderate disturbance (Ap ~ 20). The phenomena for each calmness are discussed. Omission of days with $Ap \geq 20$ permitted exclusion of the disturbance associated with M-region and flare plasma. With the absence of M-region and flare plasma phenomena, the observed daily variation in the horizontal intensity in low latitudes has two principal components: under quiet Sun conditions, a major part of the diurnal variation (88%) is associated with the dynamo-current system in the ionosphere and currents induced in the Earth; the second component, presumed to be largely of solar-wind origin, is a southward field and its magnitude is largest between 1900 and 2100 hours LT. (J.C.W.)

PHYSICS (ATOMIC AND MOLECULAR)

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 28124, 29942, and 30119.

29056 (CONF-720404-5) PRESENT AND FUTURE APPLICATIONS OF AUGER SPECTROSCOPY. Carlson, Thomas A. (Oak Ridge National Lab., Tenn.). [1972]. 33p. Dep. NTIS.

From International conference on inner shell ionization phenomena; Atlanta, Ga. (17 Apr 1972).

Because of the high scattering cross section for low-energy electrons in matter, studies on the Auger effect have been somewhat limited. However, in two situations, gases at low pressures and surfaces of solids, Auger electrons may be measured with ease. During the last few years increased attention has been paid to Auger spectroscopy as a means for studying other atomic and molecular properties. With gases Auger spectroscopy has been helpful in yielding information regarding initial excitation phenomena and the nature of doubly charged molecules, as well as providing a method for gas analysis. With solids, Auger spectroscopy has become a powerful tool for surface analysis, especially when combined with other surface techniques such as low-energy electron diffraction (LEED) and scanning electron microscopy. An outline of the present uses of Auger spectroscopy is given together with some suggestions for the future. (46 references) (auth)

29057 (CONF-720404-6) ENERGY SHIFTS AND RELATIVE INTENSITIES OF K X-RAYS PRODUCED BY SWIFT HEAVY IONS. Saltmarsh, M. J.; van der Woude, A.; Ludemann, C. A. (Oak Ridge National Lab., Tenn.). [1972]. 14p. Dep. NTIS.

From International conference on inner shell ionization phenomena; Atlanta, Ga. (17 Apr 1972).

The energy shifts of K x rays produced by 5-MeV/amu He, C, O, and Ne ions and by 10-MeV/amu C ions on targets of Fe, Co, Zr, and Sn were measured; additional data for Ti and Fe were obtained using O ion energies from 0.625 MeV/amu to 2.84 MeV/amu. In the case of the 5-MeV/amu and 10-MeV/amu data, it was found that for each target there exists a nearly linear relationship between the observed energy shift and the stopping power for the bombarding ion. The projectile energy dependence of the shift for Ti and Fe targets obtained from the O data shows a form similar to that predicted for the L-ionization cross section. The observed K_β/K_α ratios show the same type of simple systematics, suggesting that these multiple ionization phenomena can be quantitatively explained within the framework of existing Coulomb excitation theories. (auth)

29058 (CONF-720404-7) ON THE Z^2-DEPENDENCE OF THE X-RAY PRODUCTION CROSS SECTION BY 5-MeV/amu HEAVY IONS. van der Woude, A.; Saltmarsh, M. J.; Ludemann, C. A.; Hahn, R. L.; Eichler, E. (Oak Ridge National Lab., Tenn.). [1972]. 11p. Dep. NTIS.

From International conference on inner shell ionization phenomena; Atlanta, Ga. (17 Apr 1972).

Large deviations from a Z^2 dependence for the x-ray production cross sections are found for K x rays of Ti, Fe, Co, Zr, Sn, and Nd and L x rays of Sn and Nd using 5 MeV/amu He, C, O, and Ne ions as projectiles. At least in the case of the K x rays of Zr, Sn, and Nd, these deviations very likely reflect the behavior of the ionization cross section and point out the necessity of adding a Z^3 term to the expression for the ionization cross section. In the other cases the uncertainty of the fluorescence yield prevents the drawing of any definite conclusions. (auth)

29059 (FRNC-TH-146) DEVELOPMENT OF A LAMINAR ELECTRON BEAM WITH AN ENERGY BETWEEN 100 AND 300 keV FOR IRRADIATING THIN FILMS. Lemaire, Josiane (Grenoble Univ. (France)). 1971. 95p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Various optical devices (a sweeping system using an alternating magnetic field, an elongating system using a quadrupolar lens, and magnetic prisms) were developed in a program involving the production of an electron-beam scanning system (energy 100 to 300 keV, intensity $\geq$ mA, surface covered 100×2 cm^2). In the case of 300-keV electrons, the vacuum enclosure is sealed by sticking a piece of thin Ti foil (110×3 cm, 25 μ thick), over the aperture. In the case of a 100-keV beam, an Al foil (110×3 cm, 15 μ thick) supported by a grid is used. The characteristics of the beam after traversing a 5-μ Al window are as follows: the energy peak width is between 10 and 300 keV (measured with a Si semiconductor detector having a 500-μ surface barrier); the electron density is homogeneous to within 5% over the meter. (France)

29060 (SC-DC-722235) CROSS SECTIONS FOR INNER SHELL IONIZATION OF ATOMS BY ELECTRON IMPACT. Gerlach, Robert L.; DuCharme, A. R. (Sandia Labs., Albuquerque, N. Mex.). [1971]. 14p. (CONF-720404-2). Dep. NTIS.

From International conference on inner shell ionization phenomena; Atlanta, Ga. (17 Apr 1972).

Total and differential backscattered cross section measurements for inner-shell ionization of surface atoms are reported. These include the total cross section for C and differential backscattered cross sections for C, Mg, and Ba. The total-cross-section data are well described by a Born approximation theory for K-shell ionization. The differential backscattered measurements of K- and L-shell ionization as a function of primary electron energy are not adequately represented by the same theory. (auth)

29061 MONOENERGETIC ELECTRON BEAM IN THE FIELD OF A CYLINDRICAL CONDENSER. Mezentsev, A. P.; Fedorov, V. L.; Kadyrova, V. S. (Mining Inst., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 10, 1720-3(Apr 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 10, 2170-4(Oct 1971).

The optimum design for the cylindrical condenser used to produce a monoenergetic electron beam is analyzed. The electrostatic field of the cylindrical condenser is determined taking account of diaphragms at the ends. It is shown that the optimum opening angle for the condenser is 118°30′ for a cylinder radius ratio of 1.3. Curves are given which can be used to evaluate the beam attenuation and monoenergetic properties. (auth)

29062 ION COMPONENT IN CATHODE SPUTTERING OF METALS. Adylov, A. A.; Veksler, V. I.; Reznik, A. M. (Tashkent State Univ.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1588-9(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 2005-7(Sep 1971).

The sputtering of a polycrystalline tungsten target in the ionic state by bombardment with Pb^+ and Cs^+ ions was investigated. The experiment shows for the first time that more than 90% of the W ions are emitted from regions of the surface which are in an atomically pure state; this result indicates the need for a theory for the ion component in cathode sputtering. (auth)

29063 RUTHERFORD BACK SCATTERING OF PROTONS AT MEDIUM ENERGIES. Cawthron, E. R. (Australian National Univ., Canberra). Aust. J. Phys.; 25: No. 1, 113-15(Feb 1972).

A plot of the total number of backscattered ions with energy >E against E_0 for protons on Ni and Pt targets, together with some earlier results, indicates that backscattering of protons from metal targets in the 3 to 10-keV range is approximately Rutherford and that backscattered particles are predominantly neutral up to several keV, with an average energy less than that of the scattered protons alone. (Australia)

29064 DEVICE FOR PRODUCING HIGH INTENSITY ION BEAMS. (to Thomson-CSF). British Patent 1,268,941. 29 Mar 1972. Priority date 9 Apr 1968, France.

The device consists of a duoplasmatron and a reaction chamber to receive the plasma beam. The apparatus consists of means for introducing the plasma into the chamber, and an exit orifice for the escape of reaction products from the chamber. (M.O.W.)

29065 BROADENED ENERGY DISTRIBUTIONS IN ELECTRON BEAMS. Zimmermann, Bodo (Krupp Research and Development Center, Essen). Advan. Electron. Electron Phys.; 29: 257-312(1970).

A review of the theory of broadening of energy distributions in electron beams begins with a discussion of the relation between energy spread and internal energy. An expression for estimating the energy spread is derived. General considerations regarding the shape of the broadened distributions are pointed out, and special distributions are calculated. On the basis of these results the relations between several energy widths of the same distributions can be stated. Absolute values of the energy spread for several beam geometries are calculated. The calculations are compared with experimental results. (9 figures, 5 tables, 49 references) (A.G.W.)

29066 SPUTTERING OF IRON BY FAST NEUTRONS. Baer, T. S.; Anno, J. N. (Univ. of Cincinnati). J. Appl. Phys.; 43: No. 5 2453-4(May 1972).

The atomic sputtering by fast neutrons incident upon a thin iron foil target was determined by measuring the activity of radioactive iron atoms collected during continuous exposure of

the target to a fast neutron flux of 4.0×10^{12} neutrons/cm^2 sec. The sputtering ratio (atoms of iron sputtered per fast neutron crossing the surface of the target) was found to be $(5.7 \pm 0.8) \times 10^{-3}$, assuming an isotropic neutron flux. (auth)

Atomic and Molecular Properties

Refer also to abstracts 29086, 29175, 29399, 29762, 29878, 29961, 30139, 30148–30150, 30154, 30155, and 30163.

29067 (ANU-P–538) REDUCTION OF DOPPLER-BROADENED LINE-WIDTHS IN BEAM-FOIL SPECTROSCOPY. Carriveau, G. W.; Doobov, M. H.; Hay, H. J.; Sofield, C. J. (Australian National Univ., Canberra. Research School of Physical Sciences). [1971]. 10p. Dep. NTIS (U. S. Sales Only).

A previously suggested method of reducing line widths in beam–foil spectroscopy by accepting only parallel rays of light was tried and found to be effective. Some of the characteristic features of the method were investigated. No special equipment is required. (auth)

29068 (EUR-CEA-FC–626) EXPERIMENTAL STUDY OF THE SHIFT OF LEVELS AND THE RAMAN EFFECT WITH ATOMS SUBJECTED TO THE NONRESONANT RADIATION OF A POWERFUL LASER. Platz, Peter (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct 1971. 79p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ., Orsay (France).

The definitions and basic relations concerning the description of the atom and the quantized field are recalled. Perturbation theory is then used to treat the atom field system in terms of a single quantum system; in this way the line shifts are obtained. Integration of the Schroedinger equation in the secular approximation for a two-level atom provides the first pair of side components (n = 1) of the spectrum of the wave function of the perturbed atom. A new experimental method is described, which enables the atomic line shifts due to the interaction of the atom with the radiation of a powerful laser, to be studied. This technique is applied to the Hg atom. It is shown that these shift measurements provide a new method for measuring the oscillator strengths. A nonresonant Raman transition between two excited levels of a free atom is established for the first time. (France)

29069 STIMULATED EMISSION OF LABILE MOLECULAR IONS OF DEUTERIUM BETWEEN 48 AND 84 MHz. Ionescu, A. Th. (Univ., Bucharest). Rev. Roum. Phys.; 16: No. 9, 1023-7(1971).

The existence both of the labile molecular negative ions of deuterium and their stimulated emissions is proved. The recorded emission frequencies are due to the energy variation of the magnetic moments in the magnetic field produced by the attached electron. The magnetic moments of deuterons are decoupled from the rotational angular momentum of the molecule. (auth)

29070 MEASUREMENT OF LIFETIMES OF FREE ATOMS, MOLECULES, AND IONS. Corney, A. (Oxford Univ.). Advan. Electron. Electron Phys.; 29: 115-231(1970).

Atoms, ions, and molecules in excited electronic levels tend to decay spontaneously to low energy levels of their respective systems by the emission of electric dipole radiation. The theoretical relationships for electric dipole radiation are discussed. The spontaneous decay is discussed on the basis of the classical theory of electromagnetism; the excited electron in an atom is represented by a harmonically bound point charge that oscillates at the angular frequency, ω_0, then the accelerated electron becomes a source of electromagnetic waves of the same angular frequency. Although agreement with experiment is good, it is unwise to apply the classical theory to transitions other than the resonance lines. For general applicability, it is necessary to consider the interaction of atoms and radiation described by the quantum theory by treating the atoms quantum-mechanically while retaining a classical description of the electromagnetic field or by a complete treatment in which the electromagnetic field is fully quantized. Electric dipole transitions from an excited level of a diatomic molecule are considered. Measurement techniques reviewed include: direct measurement of f-values, direct observation of exponential decays using analog methods, delayed coincidence photon counting, beam–foil and phase-shift techniques, observation of radiation width and pressure broadening of spectral lines, and resonance fluorescence techniques. Methods involving laser transitions, metastable levels, and autoionizing levels are discussed. (14 tables, 36 figures, 343 references). (J.C.W.)

29071 PERTURBATION CALCULATION ON HELIUM. Devine, K. R.; Stewart, A. L. (Queen's Univ., Belfast). J. Phys., B (London); 5: No. 3, 432-7(Mar 1972).

A calculation of the energy and various expectation values of the 1^1S, $2^{1,3}S$, and $2^{1,3}P$ states of helium using perturbation theory is described. The method is based on zero-order wave functions generated by the frozen-core Hartree–Fock approximation. To fourth order in the energy and second order in the wave functions excellent agreement with the calculations of Pekeris is obtained. (auth)

29072 ANALYSIS OF THE SPECTRUM OF QUADRUPLY IONIZED YTTRIUM (Y V). Reader, Joseph; Epstein, Gabriel L. (National Bureau of Standards, Washington, D. C.). J. Opt. Soc. Amer.; 62: No. 5, 619-22(May 1972).

The Y V spectrum was observed in a sliding-spark discharge with the NBS 10.7-m normal-incidence vacuum spectrograph. The analysis yielded all the levels of the $4p^5 5s$ configuration and nearly all levels of $4p^4 4d$ that can combine with the $4p^5\ ^2P$ ground term. The $4s^2 4p^4 4d + 4s^2 4p^4 5s + 4s4p^6$ levels have been theoretically interpreted, including configuration-interaction effects. The $4s4p^6\ ^2S_{\frac{1}{2}}$ level was found to have a 26% $4s^2 4p^4 4d(^1D)^2S$ character and the $4s^2 4p^4 4d(^1D)^2S_{\frac{1}{2}}$ level at 22% $4s4p^6\ ^2S$ character. The energy parameters determined from a least-squares fit of the observed level values are compared with Hartree–Fock calculations. The ionization energy is estimated to be 75.0 ± 0.5 eV. (auth)

29073 POSSIBILITY OF INVESTIGATING ATOMIC AUTOIONIZING STATES IN COINCIDENCE EXPERIMENTS. Balashov, V. V.; Lipovetskii, S. S.; Senashenko, V. S. (Moscow State Univ.). Phys. Lett.; 39A: No. 2, 103-4(24 Apr 1972).

The possibility of investigating atomic autoionizing states in coincidence experiments on inelastic scattering of fast particles is discussed. The calculations have been performed for the $(2s2p)\ ^1P^{(-)}$-state of helium. (auth)

29074 NONSYMMETRIC PERTURBATION CALCULATIONS OF EXCITED STATES OF HELIUM. Riley, Merle E. (Sandia Labs., Albuquerque, N. Mex.); Schulman, Jerome M.; Musher, Jeremy I. Phys. Rev., A; 5: No. 5, 2255-9(May 1972).

Perturbation-theoretic calculations are carried out for the lowest five states of the helium atom using a Hamiltonian that is not symmetric in the particle indices such that the zeroth-order spatial functions can be written as simple products of hydrogenic orbitals. The perturbation expansions are reasonably convergent except for the fifth state, which is divergent as expected. By 19th order in the expansion the energies of the first two excited states are accurate to 2×10^{-4} and the expectation values of $\frac{1}{2}(1 \pm P)$ are accurate to 1×10^{-4}. (auth)

29075 HIGHLY EXCITED STATES OF HYDROGEN MOLECULES. I. H_2, HD, AND D_2. Barnett, C. F. (Oak Ridge National Lab., Tenn.); Ray, J. A.; Russek, A. Phys. Rev., A; 5: No. 5, 2110-20(May 1972).

Highly excited states of hydrogen molecules were formed by electron-capture collisions of 50- to 450-keV diatomic ions in hydrogen gas. Populations of the excited states ($n \geq 10$) were determined by passing the molecules through an intense electric field, which strips the excited electron from the molecule. The fraction of molecules in states $n \geq 10$ was approximately 10^{-3} with D_2^+ being approximately a factor of 2 greater than H_2^+. The fractional yield of H_2^+ varied as the stripping electric field to the $\frac{3}{4}$ power. Results are presented for molecular autoionization, excited-state population dependence on ion-source-electron energy, and state-mixing measurements. (auth)

29076 HIGHLY EXCITED STATES OF HYDROGEN MOLECULES. II. H_3. Barnett, C. F.; Ray, J. A. (Oak Ridge National Lab., Tenn.). Phys. Rev., A; 5: No. 5, 2120-2(May 1972).

Highly excited principal quantum states of H_3 molecules formed by electron-capture collisions of H_3^+ in H_2 gas were observed. An intense electric field was used to strip the orbital electron from the excited H_3. Comparison with data obtained with excited H_2 indicates that the fraction of H_3 ionized was proportional to the $\frac{3}{4}$ power of the electrostatic-stripping field. (auth)

29077 HYPERFINE AND ZEEMAN INTERACTIONS IN THE METASTABLE, $c\ ^3\Pi_u$, STATE OF H_2. Jette, A. Norman (Johns Hopkins Univ., Silver Spring, Md.). Phys. Rev., A; 5: No. 5, 2009-13(May 1972).

The magnetic hyperfine and g_F constants were calculated for the $c\ ^3\Pi_u(1s, 2p)$ metastable state of H_2 using wave functions determined from the optimal-double-configuration model. The hyperfine constants differ by as much as 24% from previous values obtained using a single-configuration electronic wave function. The hyperfine constants are a = 21.98 MHz, b = 471.14 MHz, c = 59.37 MHz, d = –12.87 MHz, where a and b are the orbital interaction of the electron with the nucleus and the Fermi contact interaction, respectively, and c and d arise from the dipolar interaction of electron and nucleus. With these values for the hyperfine constants, along with the experimental fine-structure

splittings and a matrix-diagonalization procedure, the g_F values were calculated and found to be in better agreement with experiment than the earlier theoretical values. (auth)

29078 SECOND-ORDER CORRECTIONS TO THE FINE STRUCTURE OF HELIUM. Hambro, Lars (Univ. of Oslo). Phys. Rev., A; 5: No. 5, 2027-45(May 1972).

The fine-structure constant can be determined to high accuracy from precise measurements of the fine structure of the $2\,^3P$ level in helium. One of the necessary calculations is to compute the contributions from the six Breit operators and the mass-polarization operator in second-order perturbation theory. The eighteen spin-dependent perturbations from intermediate ^3P states are calculated by solving an inhomogeneous Schrödinger equation for the perturbation of the wave function by the variational method. The second-order contributions are then given by a single integral. These corrections are calculated using standard Hylleraas expansions with up to 165 terms for the perturbed wave functions, resulting in contributions to the two fine-structure intervals of the order of 10^{-4} cm^{-1}, but only four of the results are sufficiently accurate. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 29096, 29287, and 30120.

29079 (JINR-P4-6254) CALCULATION OF THE $p\mu + He^{++}$ REACTION. Matveenko, A. V.; Ponomarev, L. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics) Feb 1972. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The cross section is calculated for μ^--meson transfer from the ground state of mesic atoms $p\mu$ and $d\mu$ to He^{2+} at small collision energies. The calculated results are compared with theoretical and experimental estimates. (auth)

29080 (JINR-P4-6256) CALCULATION OF THE ENERGY LEVELS OF MESIC MOLECULES BY THE CONTINUOUS ANALOG OF THE NEWTON METHOD. Ponomarev, L. I.; Puzynin, I. V.; Puzynina, T. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1972. 24p. (In Russian). Dep. NTIS (U. S. Sales Only).

Development of the method of numerical solution of the Sturm-Liouville problem, having a number of advantages as compared with the known methods, was based on the continuous analog of the Newton method. The method is used in solving the coupling energies of mesic molecules: $pp\mu$, $dd\mu$, $tt\mu$. (auth)

29081 TEMPERATURE DEPENDENCE OF POSITRON ANNIHILATION IN HELIUM, NEON, AND ARGON. Grover, P. S.; Srivastava, M. P. (Univ. of Delhi). J. Phys., B (London); 5: No. 3, 609-16(Mar 1972).

The annihilation decay rates of positrons in He, Ne, and Ar were calculated as a function of temperature. This was done by solving the Boltzmann diffusion equation by an iterative procedure. The annihilation decay rate decreases with increasing temperature. In the case of He and Ne, this dependence is weak, but in Ar there are appreciable variations. A comparison is made between the theoretical and experimental results, and the agreement is reasonable. (auth)

29082 BEHAVIOUR OF POSITRONS IN MOLECULAR GASES. II. DEPENDENCE OF ANNIHILATION RATES OF POSITRONS IN RARE GASES ON THE PRESENCE OF MOLECULES. Massey, H. S. W.; Lawson, J.; Hara, S. (University Coll., London). J. Phys., B (London); 5: No. 3, 599-608(Mar 1972).

The dependence upon molecular concentration of the equilibrium distribution and annihilation rates of slow positrons in mixtures of rare gases with N_2 and CO was investigated theoretically. The equilibrium annihilation rate is found to approach a constant value as the concentration of the molecule is increased. (auth)

Collision Phenomena

Refer also to abstracts 29075, 29076, and 29899.

29083 (NP-19126) APPLICATION OF PERTURBATION THEORY FOR DESCRIBING MULTIPHOTON PROCESSES IN THE IONIZATION OF ATOMS. Delone, G. A.; Delone, N. B.; Manakov, N. L.; Piskova, G. K. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The use of perturbation theory for describing many-photon ionization, and its limits as fixed by field intensity, are elucidated through a comparison of experimental and theoretical values of the probability of a fourth-photon ionization of a potassium atom irradiated by a neodymium laser. This probability was studied as a function of the radiation frequency. The change in ion signal was investigated with relation to the intensity of radiation. (K.S.W.)

29084 CHANGE OF THE VIBRATIONAL DISTRIBUTION FUNCTION IN TRANSITIONS BETWEEN ELECTRON STATES IN DIATOMIC MOLECULES DUE TO COLLISIONS WITH ELECTRONS. Mnatsakanyan, A. Kh.; Podlubnyi, L. I. (Inst. of High Temperatures, Moscow. Moscow Power Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 10, 1680-3(Apr 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 10, 2121-5(Oct 1971).

An analytic expression is obtained for the populations of the vibration levels of an emission state of a diatomic molecule in the case of direct excitation by electron impact from the ground state. The results agree with numerical calculations of other authors. (auth)

29085 APPLICATION OF THE EXPANSION TECHNIQUE OF HARRIS AND MICHELS TO ELECTRON-HYDROGEN INELASTIC SCATTERING. Smith, R. L.; Truhlar, D. G. (Univ. of Minnesota, Minneapolis). Phys. Lett.; 39A: No. 1, 35-7(10 Apr 1972).

The algebraic variational method of Harris and Michels was applied to the calculation of reactance matrix elements in electron-hydrogen scattering, using the 1s-2s-2p close-coupling approach. The results are compared to those obtained using other methods. (auth)

29086 RADIATIVE LIFETIMES AND TRANSITION PROBABILITIES FOR Xe I AND Xe II. Karimov, P. G.; Klimkin, V. M. (Tomsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 3, 24-9(1971). (In Russian).

The lifetimes of 10 atomic levels and of two ionic levels of Xe were measured. The effective deactivation cross section during collisions was evaluated for the $2P_8$ level of a Xe atom. (tr-auth)

29087 ATOM-ATOM AND ATOM-ION COLLISIONS. II. COLLISIONS BETWEEN ATOMS AND IONS IN WHICH NO EXCITATION OCCURS: SYMMETRICAL CHARGE TRANSFER. Massey, Harrie (University Coll., London). Contemp. Phys.; 13: No. 2, 135-58(Mar 1972).

A number of new features appear in elastic collisions between atoms when one of the colliding systems is a positive ion. An account is given first of some of these features, due to the long-range polarization force, which arise whether or not the ion and atom are of the same species. When they are of the same species symmetrical charge transfer may occur without change of internal energy and this leads to a number of further interference effects, the nature of which is described in general semiclassical theoretical terms. An account is given of experiments that have confirmed the nature and existence of these effects. (auth)

29088 COLLISIONS OF N_2^+ IONS ON NOBLE GAS ATOMS. II. Fayeton, J.; Pernot, A.; Barat, M.; Fournier, P. (Univ. Paris, Orsay, France). J. Phys. (Paris); 32: No. 10, 743-50 (Oct 1971).

The scattering without dissociation of N_2^+ molecular ions by noble gas atom targets (Xe, Ar, and He) was investigated. In the laboratory coordinate system, the collision energy ranged from 0.3 to 3 keV and the scattering angles ranged from 0.8° to 7°. An analysis of the energy loss of the scattered N_2^+ ions revealed the existence of several competitive processes falling into two categories: elastic scattering and vibrational excitation; electronic excitation of the projectile and target. Processes falling into the first category are compared with the binary model. The different excitation processes are interpreted in the same way. Electronic and vibrational excitation can occur simultaneously. In the collision, the molecule and the target are considered as a quasi-molecular complex decaying into several channels through potential surface crossing. (France)

29089 CHARGE EXCHANGE SCATTERING AMPLITUDE TO FIRST ORDER OF A THREE BODY EXPANISON. Gayet, R. (Observatoire de Paris, Meudon, France). J. Phys., B (London); 5: No. 3, 483-91(Mar 1972).

An analytical scattering amplitude for charge-exchange processes is derived by means of a quantum three-body theory for rearrangement collisions. This expression is the rigorous first-order term of a perturbation series and should be useful in the intermediate- and high-energy range, say $E > 25$ keV. It is equivalent to the continuum distorted-wave approximation introduced by Cheshire (1964) by means of an impact-parameter method. (auth)

29090 3s AND 3p EXCITATIONS OF ATOMIC HYDROGEN BY PROTON AND α-PARTICLE IMPACT. Chaudhuri, J.; Bhattacharya, D. M.; Sil, N. C. (Indian Association for the Cultivation of Science, Calcutta). J. Phys., B (London); 5: No. 3, 525-32(Mar 1972).

The excitation of hydrogen atoms by α-particle impact and by proton impact from the ground state to the 3s and 3p levels in the energy range 30 to 2000 keV was investigated using the method of distortion. A comparison of the results with the corresponding results obtained by the first and second Born and the approximation of Cheshire and Sullivan (1967) shows that the effect of distortion is to reduce the cross sections and that this effect is greater on the 1s → 3s transition than on the 1s → 3p transition. (auth)

29091 EFFECT OF 2s–2p CLOSE COUPLING ON THE CROSS SECTION FOR EXCITATION OF THE 2p STATE OF THE HYDROGEN ATOMS BY ELECTRONS AT HIGH ENERGIES. Damburg, R.; Propin, R. (Inst. of Physics, Riga). J. Phys., B (London); 5: No. 3, 533-6(Mar 1972).

A model problem with close coupling is considered. It is shown that even at energies ~200 to 1000 eV the 2s–2p coupling can account for a 20% change in the cross section for excitation of the 2p state. (auth)

29092 USE OF SECOND ORDER POTENTIALS IN THE THEORY OF THE SCATTERING OF CHARGED PARTICLES BY ATOMS. I. GENERAL THEORY. Bransden, B. H.; Coleman, J. P. (Univ. of Durham, Eng.). J. Phys., B (London); 5: No. 3, 537-45(Mar 1972).

Equations for approximate wave functions describing the scattering of charged particles by atoms are often obtained by using a truncated-eigenfunction (or close-coupling) expansion. It is shown how allowance can be made for the states omitted in the expansion, by the introduction of suitable second-order potentials. The potentials are evaluated in a closure approximation and depend on an effective energy parameter, which can be chosen so that the correct long-range interaction is obtained in the incident channel. An impact-parameter version of the method is introduced and the relation to the Glauber approximation is discussed. (auth)

29093 USE OF SECOND ORDER POTENTIALS IN THE THEORY OF SCATTERING OF CHARGED PARTICLES BY ATOMS. II. ELECTRON AND PROTON SCATTERING BY HYDROGEN ATOMS. Bransden, B. H.; Coleman, J. P.; Sullivan, J. (Univ. of Durham, Eng.). J. Phys., B (London); 5: No. 3, 546-58(Mar 1972).

The method described by Bransden and Coleman (J. Phys. B. (London), 5: 537(1972)) is applied to collisions of electrons and protons with atomic hydrogen. One-channel and two-channel approximations are used, and results are presented for elastic scattering and 1s–2s, 1s–2p, and 1s–3p excitation. (auth)

29094 CORRELATION DIAGRAMS: THEIR USE IN THE INTERPRETATION OF HEAVY ION-ATOM INELASTIC COLLISIONS. Larkins, F. P. (Monash Univ., Clayton, Australia). J. Phys., B (London); 5: No. 3, 571-8(Mar 1972).

Curves of orbital energy against internuclear separation (correlation diagrams) for the symmetric Ne–Ne and the asymmetric Ne–Ar systems have been determined using an ab initio Hartree–Fock molecular-orbital method. On the basis of these findings the usefulness of the electron-promotion mechanism, proposed by Fano and Lichten (1965), in accounting for inner-shell vacancy formation resulting from heavy-ion–atom collisions is evaluated. The mechanism is considered to be of most value in explaining the findings related to the formation of L-shell vacancies. In some asymmetric systems where there is evidence for the production of K-shell vacancies it was shown that the electron-promotion mechanism is not applicable. Other experimental results are interpreted as providing direct evidence that the adiabatic approximation is not strictly valid for these collision processes. The findings suggest that more detailed calculations using a modification of direct scattering theory are required. (auth)

29095 VALIDITY OF FRANCK–CONDON PRINCIPLE FOR $H^+ \rightarrow H^-$ DOUBLE CHARGE TRANSFER OF FAST PROTONS ON H_2 AT LOW SCATTERING ANGLE. Fournier, P. G.; Appell, J.; Fehsenfeld, F. C.; Durup, J. (Paris Univ., Orsay, France). J. Phys., B (London); 5: No. 3, L58-62(Mar 1972).

Translational energy spectra of H^- ions arising from single- and double-collision double charge transfer of 4-keV protons on H_2 at small scattering angles were measured. Comparison of the energy losses corresponding to the observed peaks with the expected values shows that the Franck–Condon principle is obeyed in such collisional transitions. (auth)

29096 BEHAVIOUR OF POSITRONS IN MOLECULAR GASES. I. ROTATIONAL EXCITATION OF MOLECULES BY SLOW POSITRONS. Hara, S. (University Coll., London). J. Phys., B (London); 5: No. 3, 589-98(Mar 1972).

Cross sections for the rotational excitation of H_2, N_2, and O_2 by the impact of slow positrons are calculated in the distorted-wave approximation. The effects of long-range and short-range interaction are investigated. It is found that inclusion of the short-range interaction affects the cross sections appreciably. (auth)

29097 HIGH ENERGY APPROXIMATION. III. HELIUM EXCITATION BY ELECTRONS. Hidalgo, M. B.; Geltman, S. (National Bureau of Standards, Boulder, Colo. Univ. of Colorado, Boulder). J. Phys., B (London); 5: No. 3, 617-26(Mar 1972).

The cross sections for the direct excitation of the 2^1S and 2^1P states of helium by electron impact are evaluated in a first-order approximation in which the interaction between the incident electron and the target nucleus is represented by a Coulomb-wave final state in the T matrix. The results obtained for the differential cross sections are much greater than those of the Born approximation for large scattering angles, and the present results are in much better agreement with experiment. The present calculation predicts inelastic differential cross sections that have the asymptotic energy dependence of E^{-3} for all non-zero angles of scattering. The total cross sections converge to the Born values at high energy. (auth)

29098 MEASUREMENTS OF LARGE ANGLE INELASTIC SCATTERING CROSS SECTIONS FOR ELECTRONS ON HELIUM. Opal, C. B.; Beaty, E. C. (Univ. of Colorado, Boulder). J. Phys., B (London); 5: No. 3, 627-35(Mar 1972).

The ratios of the inelastic electron scattering cross sections for the n = 2 levels of helium to the corresponding elastic scattering cross sections were measured in a crossed-beam apparatus over the 30° to 150° range for incident energies of 82 and 200 eV. In both cases, at angles greater than 40° the ratio of the sum of the inelastic cross sections to the elastic cross section was constant at a few percent, in qualitative agreement with a similar experiment in atomic hydrogen by Williams (1969). The four n = 2 states were observed to have markedly different angular dependencies at 82 eV. Only the ^1S and ^1P states were important at 200 eV; the ratio $^1S/^1P$ was very nearly 2 at all angles larger than 60°. Within experimental error, over the range of variables studied, the observed cross sections agreed with those predicted by the first Born approximation only for ^1P at angles less than 45° at 82 eV incident energy and for ^1S and ^1P at 30° and 200 eV incident energy. (auth)

29099 HYDROGEN CHARGE FRACTIONS FROM COLLISIONS OF H^- ON He. McCaughey, M. P.; Bednar, J. A. (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev. Lett.; 28: No. 16, 1011-13(17 Apr 1972).

Measurements of hydrogen charge fractions following the collision of H^- on He are reported. Incident energy is varied from 0.47 to 20 keV. The charge fractions were measured at scattering angles of 0.3° to 5°. A large neutral charge fraction is found at all energies and angles. At high energies, the elastic channel has a simple velocity dependence. A simple model for this elastic channel is proposed. (auth)

29100 YIELDS OF K AND L X RAYS ARISING FROM 2- TO 30-MeV PROTON BOMBARDMENT OF Ag. Bissinger, G. A. (Univ. of North Carolina, Chapel Hill. Triangle Universities Nuclear Lab., Durham, N. C.); Shafroth, S. M.; Waltner, A. W. Phys. Rev., A; 5: No. 5, 2046-52(May 1972).

Ag K and L x-ray yields were measured for 2- to 30-MeV protons incident on a thin Ag foil target with a Si(Li) x-ray detector (resolution 540 eV at 6 keV). The absolute K-shell ionization cross section σ_K extracted from these measurements was compared to plane-wave-Born-approximation (PWBA) and binary-encounter-approximation (BEA) calculations and agrees quite well with both over the energy range covered. However, the PWBA and BEA predictions of L-shell ionization cross sections are low by a factor close to 2 compared to experimental values for σ_L, although both predict an energy dependence for the shape of σ_L in good agreement with that observed. The disagreement in magnitude is most likely because of the present inadequate L-shell fluorescence yields for medium- and low-Z atoms. The $K\alpha/K\beta$ x-ray intensity ratio for proton bombardment of Ag from 2 to 30 MeV was observed to be constant (4.68 ± 0.33) and consistently slightly below Scofield's calculation (5.09). The unresolved $K\beta$ peak was decomposed into its two major components $K\beta_{1,3}$ and $K\beta_2$ whose ratio appeared to be weakly dependent on proton-beam energy. (auth)

29101 ABSOLUTE ELASTIC AND INELASTIC DIFFERENTIAL CROSS SECTIONS FOR SCATTERING OF LOW-ENERGY ELECTRONS BY POTASSIUM. Slevin, James A.; Visconti, Paul J.; Rubin, Kenneth (City Coll., New York). Phys. Rev., A; 5: No. 5, 2065-77(May 1972).

A new method for obtaining absolute differential excitation cross sections in low-energy electron–atom scattering is employed. The method utilizes certain of the kinematic properties of a recoiling-atom beam in an electron–atom crossed-beam configuration to distinguish between elastic scattering events and

excitation to various atomic levels. Differential cross sections for elastic scattering and excitation of the 4p state of potassium are presented at 1.0, 3.0, 4.4, and 5.2 eV. A combined cross section for the 4s-5s, 3d excitation integrated over a restricted angular range is also presented. (auth)

29102 COLLISIONAL QUENCHING OF METASTABLE HYDROGEN ATOMS. Krotkov, Robert V.; Byron, F. W. Jr.; Medeiros, John A.; Yang, K. H. (Univ. of Massachusetts, Amherst). Phys. Rev., A; 5: No. 5, 2078-84(May 1972).

The cross section for the quenching (i.e., depopulation) of the 2s (metastable) state of atomic hydrogen by collisions with atoms of helium and argon was measured. The energy range covered was 0.25 to 30.0 keV. The experimental technique was to measure the attenuation of a beam passing through the various gases, the detector being a Lyman-α counter viewing a section of the beam where a dc electric field mixed 2s and 2p states, which essentially converted metastable atoms into Lyman-α photons. For helium as target gas, the cross section was also calculated using a pseudopotential and the eikonal approximation. For helium, the measured cross section falls rapidly as the energy increases from 0.25 to 2.5 keV and remains roughly constant at $7.5\pi a_0^2$ from 2.5 to 30 keV. The theoretical curve is about a factor of 4 below the measured value. Implications of this discrepancy are discussed in the text. For argon, the measured cross section increases from $20\pi a_0^2$ to $27\pi a_0^2$ as the energy increases from 1 to 30 keV. (auth)

29103 LOW-ENERGY THEORETICAL INELASTIC-SCATTERING DIFFERENTIAL CROSS SECTIONS FOR THE PROCESS $He^+ + He \rightarrow He^+ + He(2^3S)$. Olson, Ronald E. (Stanford Research Inst., Menlo Park, Calif.). Phys. Rev., A; 5: No. 5, 2094-2103 (May 1972).

Coupled-channel calculations were performed at 27.5, 30, and 50 eV for the reaction $He^+ + He \rightarrow He^+ + He(2^3S) + 19.81$ eV using presently available ab initio potentials for the two lowest $^1\Sigma_g^+$ states. The inelastic-scattering differential cross sections were calculated at these energies and are compared with recent experimental results. Several features are distinguished on the calculated cross sections. All possess low-frequency Stückelberg oscillations and a higher-frequency oscillation due to the nuclear symmetry of the reactants. At the two lowest energies of 27.5 and 30 eV, inelastic rainbow-type oscillatory structure is also observed. The inelastic rainbow structure was due to the maximum on the excited-state potential and the closeness of the collision energy to the threshold for this reaction. The elastic differential cross sections were calculated at 50 eV, and perturbations due to the crossing of the inelastic channel were found superimposed upon the electron and nuclear exchange oscillations. (auth)

29104 EXCITATION OF H ATOMS TO THE n = 3 STATES BY THE IMPACT OF 10- TO 35-keV GROUND-STATE H ATOMS ON He, Ne, Ar, H_2, O_2, AND N_2. Hughes, R. H.; Petefish, H. M.; Kisner, H. (Univ. of Arkansas, Fayetteville). Phys. Rev., A; 5: No. 5, 2103-6(May 1972).

Absolute cross sections were measured for the excitation of hydrogen atoms to the 3s, 3p, and 3d states by the impact of ground-state hydrogen atoms on He, Ne, Ar, H_2, O_2, and N_2 in the energy range from 10 to 35 keV. In this energy range the cross sections for the different angular momentum states are generally the same order of magnitude (10^{-18} cm^2). Excitation to the s state is more competitive with the p-state excitation at the n = 3 level than at the n = 2 level. Excitation to the 3d state is not as likely as excitation to the 3s or 3p states. Cross sections for the production of Balmer-α radiation were computed. Polarization fractions for the 3d $\rightarrow$ 2p radiation were also measured. (auth)

29105 DESTRUCTION OF THE 3s STATE IN ATOMIC HYDROGEN BY FAST-ATOM IMPACT ON N_2, Ar, AND H_2. Hughes, R. H.; Kisner, H. (Univ. of Arkansas, Fayetteville). Phys. Rev., A; 5: No. 5, 2107-9(May 1972).

Cross sections were determined for the destruction of the 3s state in atomic hydrogen by 10-, 25-, and 35-keV hydrogen-atom impact on N_2, Ar, and H_2. The experimental values support the concept of two destruction mechanisms. One mechanism involves the collisional ionization of the excited atom, which has been treated quantitatively by Bates and Walker. The other mechanism involves electron capture by the fast-atom nucleus. (auth)

29106 e-H SCATTERING BY THE FADDEEV APPROACH. Sil, N. C.; Ghosh, A. S. (Indian Association for the Cultivation of Science, Calcutta). Phys. Rev., A; 5: No. 5, 2122-6(May 1972).

1s-1s elastic and 1s-2s inelastic total cross sections for e-H collisions were calculated with and without exchange effects using the Faddeev formalism as developed by Sloan and Moore. The effect of coupling to 1s and 2s intermediate states was considered. These theoretical results were compared with the existing experimental findings and other theoretical calculations. In the intermediate-energy region, the results for the inelastic process are found to be in close agreement with the experimental observations. The results for both systems indicate that coupling to states other than the initial and final ones causes a reduction in the cross sections, and even up to 500 eV the effect of exchange is not negligible. (auth)

29107 (e^+,He) TOTAL SCATTERING. Costello, D. G. (Gulf Energy and Environment Inc., San Diego, Calif.); Groce, D. E.; Herring, D. F.; McGowan, J. Wm. Can. J. Phys.; 50: No. 1, 23-33(1 Jan 1972).

The total scattering cross section for e^+ in He was measured through two energy intervals, 1 to 4 eV and 17 to 26 eV. Through the lower elastic-scattering interval the results are consistent with the calculations of Drachman. From below the positronium formation threshold at 17.8 eV to above the He ionization threshold the results agree qualitatively with the calculations of Kraidy, who includes in his model virtual positronium and positronium polarization. Just below 17.8 eV the cross section is 0.35 ± 0.04 πa_0^2. In these experiments a high-current linac was used as a source of positrons and total beam attenuation was used to determine the cross section. (auth)

29108 EXCITATION AND IONIZATION OF HYDROGEN BY HYDROGEN-ATOM IMPACT. Flannery, M. R. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Can. J. Phys.; 50: No. 1, 61-4(1 Jan 1972).

A semiquantal theory is applied to the examination of both the collisional excitation of the second and third excited levels of hydrogen and the collisional ionization from these levels, with the projectile hydrogen atom remaining in the ground state. Agreement with the Born cross sections is obtained. (auth)

29109 IMPACT-PARAMETER DEPENDENCE OF X-RAY PRODUCTION IN COLLISIONS BETWEEN ENERGETIC HEAVY IONS AND ATOMS. Stein, H. J.; Lutz, H. O.; Mokler, P. H.; Armbruster, P. (Kernforschungsanlage, Juelich, Ger.). Phys. Rev., A; 5: No. 5, 2126-33(May 1972).

I ions of 18 to 46 MeV were scattered by thin Te targets. The L x rays produced in the nearly identical particles I and Te were measured in coincidence with the scattered I ions. The differential cross section for L x-ray emission shows a maximum at impact parameters comparable to the L-shell radii. For the ion energies, E, investigated, the total cross section for L x-ray emission in I and Te was found to be proportional to $E^{0.8}$. The results are discussed and compared with theoretical models for inner-shell excitation. (auth)

29110 CLASSICAL ELASTIC DIFFERENTIAL CROSS SECTIONS FOR ION-ATOM SCATTERING AT keV ENERGIES. Rice, James K.; Bingham, Felton W. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., A; 5: No. 5, 2134-41(May 1972).

Classical calculations of ion-atom elastic differential cross sections for energies between 4 and 627 keV and for a variety of projectile-target combinations are presented. These calculations are based on two new interaction potentials. The first is an extension of Smith's shell potential, and the second is obtained from the unperturbed interaction of the Hartree-Fock-Slater electron densities of the target and projectile. Calculations of cross sections and distances of closest approach for these potentials are compared with predictions of the screened-Coulomb potential and the available experimental data. For collisions between light particles at energies of a few keV the static potential appears to be more accurate than the extended-shell and screened-Coulomb potentials. For collisions between heavier particles both of the new potentials are usually more accurate than the screened-Coulomb potential. (auth)

29111 ELECTRON DETACHMENT OF H^- BY e^- COLLISION. Faisal, F. H. M.; Bhatia, A. K. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., A; 5: No. 5, 2144-51(May 1972).

An impact-parameter method using Coulomb trajectories was used to calculate cross sections for the following two electron-detachment collision processes: (i) $e^- + H^- \rightarrow H(1S) + 2e^-$; (ii) $e^- + H^- \rightarrow H(2S) + 2e^-$. The cross section for process (ii) is found to be approximately two orders of magnitude smaller than that for (i). The results of process (i) are compared with the available experimental data. The plane- and Coulomb-wave cross sections in dipole approximations are calculated both at high and low energies and are compared with the semiclassical results. The asymptotic behavior of the cross sections at high energies is investigated in detail. Energy distributions of ejected electrons at three different incident energies are also calculated. (auth)

29112 DETERMINATION OF THE SCATTERING AMPLITUDE FROM THE DIFFERENTIAL CROSS SECTION FOR SCATTERING BY AN ARBITRARY NONCENTRAL POTENTIAL. Gerber, R. B. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Rev., A; 5: No. 5, 2151-62(May 1972).

The unitarity relation of quantum-scattering theory is studied for the general case of scattering by an arbitrary noncentral force and it is shown how it can be utilized to determine the phase of the scattering amplitude from the measured differential cross section. It is found that the unitarity relation leads to a pair of nonlinear integral equations for the phase of the scattering amplitude if the cross section is known. It is shown that from these equations one can obtain, without introducing approximations, a system of linear algebraic equations for a certain set of scalars from the values of which one can readily calculate the phase. In general, the above system of linear equations may admit also redundant nonphysical solutions for the phase. However, when the magnitude of the cross-section data satisfies certain conditions the solution of the equations is unique and must equal the correct physical value of the phase. Unlike previous methods for phase determination, the present approach is based on a form of the unitarity equation that is not simplified by any of the assumptions of parity, rotational, or time-reversal invariance for the underlying scattering interaction. Therefore, it can be applied to the determination of the phase also in cases such as particle scattering by, or in the presence of, external fields that do not possess the above-mentioned symmetries. A generalization of this method to many-channel scattering is also provided. Similar results hold also for the determination of phases in the theory of electromagnetic-wave scattering by an obstacle of arbitrary shape. (auth)

29113 COMMENT ON FAST-ELECTRON–SLOW-ELECTRON COINCIDENCE STUDY OF VIOLENT Ar^+–Ar COLLISIONS. Larkins, F. P. (Monash Univ., Clayton, Australia). Phys. Rev., A; 5: No. 5, 2288-9(May 1972).

In a recent Ar^+–Ar collision study by Thomson et al. (Phys. Rev., A3: 2028-34 (1971)), the lack of correlation between the energy of the emitted Auger electron and the number of coincident slow electrons was interpreted as evidence that the lifetime of the L_{23} inner-shell vacancy resulting from such collisions was not significantly longer than the lifetime of the M-shell autoionizing states. In this paper, Auger-electron energy and L_{23}-MM nonradiative lifetime calculations for the argon atom and its ions are used to demonstrate that this conclusion is not justified on the basis of the coincidence results reported. (auth)

29114 REPLY TO COMMENT ON FAST-ELECTRON–SLOW-ELECTRON COINCIDENCE STUDY OF VIOLENT Ar^+–Ar COLLISIONS. Thomson, G. M. (Georgia Inst. of Tech., Atlanta); Smith, W. W.; Russek, A. Phys. Rev., A; 5: No. 5, 2290-1(May 1972).

Comments by F. P. Larkins about a fast-electron–slow-electron coincidence study (Phys. Rev., A3: 2028-34 (1971)) of the Ar^+–Ar collision appear to raise a question on the validity of evidence that some outer-shell autoionizing states may have lifetimes comparable with those of inner-shell vacancies. In this reply, his argument is examined, and it is found that the inclusion of $L_{2,3}$–$M_1M_{2,3}$ and $L_{2,3}$–M_1M_1 transitions, as Larkin suggests, complicates the analysis but does not alter the basic conclusion originally reached. (auth)

Atomic Theory

Refer also to abstracts 29330, 29338, and 30164.

29115 MORE RAPID SOLUTIONS FOR THE HARTREE–FOCK EQUATIONS. Arifov, P. U.; Gataullin, R. (Inst. of Electronics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 3, 43-7(1971). (In Russian).

One of the methods for quantum-mechanical analysis of the many-electron problem is the numerical solution of the system of integro-differential Hartree–Fock equations for atomic, molecular, and other systems. Using the common iterative method, as many as 150 trials may be made in solving only one of the system of equations mentioned. An alternate method offered speeds up the determination of one of the constants involved. (K.S.W.)

29116 NON-RELATIVISTIC THEORY OF ATOMIC AND IONIC BINDING ENERGIES FOR LARGE ATOMIC NUMBER. March, N. H. (Univ. of Sheffield, Eng.); White, R. J. J. Phys., B (London); 5: No. 3, 466-75(Mar 1972).

The Z^{-1} expansion of the total energy of an ion with N electrons has been worked out carefully for systems with from 2 to 10 electrons, up to third order. This paper is concerned with the behavior of the energy coefficients $\epsilon_n(N)$ in the Z^{-1} expansion. The principal results are: to establish $\epsilon_n(N) \sim N^{n+\frac{1}{2}}$ for sufficiently large N, by appeal to the Thomas–Fermi theory of positive ions, to obtain the first two terms in $\epsilon_0(N)$ exactly in such an asymptotic expansion, to give approximate forms for large N for $\epsilon_1(N)$ and $\epsilon_2(N)$ and to point out that the total energy E(Z,N) can be plotted, as Z becomes large, in a universal form by considering $E(Z,N)/Z^{\frac{7}{3}}$ against N/Z. It is emphasized that the Thomas–Fermi theory of the binding energies of neutral atoms gives an approximate summation to all orders in Z^{-1} of the Z^{-1} expansion. The relation of the present theory to the result of Foldy that atomic binding energies in the range Z = 2 to 90 are approximately proportional to $Z^{\frac{11}{4}}$ is also discussed. (auth)

29117 EMPIRICAL FORMULAE FOR IONISATION POTENTIALS OF ELEMENTS. Lewin, G. F. (Brunel Univ., Uxbridge, Eng.). Phys. Lett.; 39A: No. 2, 121-2(24 Apr 1972).

A two-parameter empirical formula yielding ionization potentials for several isoelectronic series to within ±5%, suitable for interpolation in computer programs, is proposed, and its significance is discussed. (auth)

29118 ELECTRON SPIN–SPIN CONTACT INTERACTION AND MASS-VARIATION AND DARWIN RELATIVISTIC CORRECTIONS IN ISOELECTRONIC SERIES. Lo, B. W. N.; Saxena, M. S.; Fraga, S. (Univ. of Alberta, Edmonton). Can. J. Phys.; 50: No. 1, 42-6(1 Jan 1972).

The values of the total electron spin–spin contact interaction and the mass-variation and Darwin relativistic corrections were calculated for a number of isoelectronic series. It is observed that the main contributions to these corrections, that are not negligible, are made by the inner electrons. (auth)

29119 RELATIVISTIC CORRECTIONS TO RADIATIVE TRANSITION PROBABILITIES. Drake, G. W. F. (Univ. of Windsor, Ont.). Phys. Rev., A; 5: No. 5, 1979-85(May 1972).

The rate of spontaneous emission of radiation by a loosely bound composite system is calculated from quantum electrodynamics correct through terms of relative order α^2Z^2. Recent criticisms by Feinberg and Sucher of the semiclassical method of deriving the higher-order radiation coupling terms are discussed. It is proved that the Breit interaction remains valid in the presence of radiation emission and that the semiclassical and quantum-electrodynamic methods of deriving the higher-order coupling terms always yield the same results to relative order α^2Z^2. In particular, relativistic corrections to allowed and spin-forbidden electric dipole transitions and the $1s2s\ ^3S_1$–$1s\ ^1S_0$ magnetic dipole transition are discussed. (auth)

29120 LOCALITY OF THE EFFECT OF THE PAULI PRINCIPLE IN ATOMS. Katriel, J. (Nuclear Research Centre-Negev, Beer Sheva, Israel). Phys. Rev., A; 5: No. 5, 1990-2(May 1972).

It is shown that the conventional application of the Pauli principle to the qualitative estimation of the relative distributions of electrons with parallel and antiparallel spins is wrong. The Pauli principle induces a local reduction of the probability of finding electrons with parallel spins close together. However, for neutral atoms at least, such electrons have a considerably higher probability of being found at moderate separations and an accompanying reduced probability of being found at higher separations, relative to electrons with antiparallel spins. (auth)

29121 EFFECT OF A DIFFUSE NUCLEAR CHARGE DISTRIBUTION ON THE HYPERFINE-STRUCTURE INTERACTION. Rosenberg, H. J.; Stroke, H. H. (New York Univ., N. Y.). Phys. Rev., A; 5: No. 5, 1992-2000(May 1972).

A diffuse nuclear charge distribution, with approximately the trapezoidal Hofstadter shape, is used to calculate the effect of the distributed nuclear charge on the magnetic-dipole hyperfine-structure (hfs) interaction between the nucleus and the atomic electron. For a surface or a uniform charge distribution model this effect is known as the Breit–Rosenthal–Crawford–Schawlow correction to the point-charge interaction. The hfs interactions calculated with the diffuse and with the uniform charge distributions differ by over 4% for medium to heavy nuclei. The results, combined with previously calculated values for the Bohr–Weisskopf correction (the effect on the hfs due to the nonpunctual distribution of nuclear magnetization), allow a more realistic determination of the total hfs anomalies, caused by the extended nuclear electric and magnetic structure, and therefore also of $|\psi(0)|^2$, the probability of the electron wave function at the origin. (auth)

29122 PAULI APPROXIMATION IN MANY-ELECTRON ATOMS. Detrich, John (Univ. of Chicago). Phys. Rev., A; 5: No. 5, 2014-27(May 1972).

The Pauli approximation for many-electron atoms is derived. This yields an unambiguous expression for the fine-structure splitting and other first-order relativistic corrections to the energy, using nonrelativistic wave functions. A formalism is

developed for atoms, based on these results, which is suitable for the evaluation of the fine structure using multiconfiguration wave functions. Fine-structure splittings calculated from Hartree–Fock wave functions are presented for the ground states from He through Ar; the remaining energy corrections are also presented. Multiconfiguration results are presented for the lowest ^1D and ^2P states of N, accounting for about 80% of the discrepancy between Hartree–Fock values and experimental values. (auth)

29123 COMPLEMENTARY VARIATIONAL PRINCIPLES IN THE THOMAS–FERMI THEORY. Csavinszky, P. (Univ. of Maine, Orono). Phys. Rev., A; 5: No. 5, 2198–2204(May 1972).

The normalization of the electron density associated with approximate variational solutions of the Thomas–Fermi (TF) equation for neutral atoms is discussed, and the applicability of a procedure of Anderson, Arthurs, and Robinson for obtaining the closest approximation is investigated. It is concluded that using single-parameter trial functions, the normalization requirement for the electron density cannot be strictly satisfied when the numerical value of the parameter is determined from the minimization of the difference between the complementary upper and lower bounds to the exact TF energy of a neutral atom. It is also concluded that, using multiple-parameter trial functions, this procedure is applicable since the numerical values of all but one of the parameters can be found from the minimum between the complementary bounds without violating the normalization requirement. (auth)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

29124 TWO-DIMENSIONAL VORTEX MOTION AND NEGATIVE TEMPERATURES. Montgomery, D. (Univ. of Iowa, Iowa City). Phys. Lett.; 39A: No. 1, 7-8(10 Apr 1972).

A recent numerical integration of the two-dimensional Navier–Stokes equations has tentatively identified an "ergodic boundary" in the space of initial conditions for the turbulent flow. An explanation is suggested in terms of negative temperatures, for a point vortex model. (auth)

29125 MAGNETOHYDRODYNAMICAL DYNAMO MODEL. Firtko, J. (Univ. for Heavy Industry, Miskolc, Hungary). Acta Phys. Acad. Sci. Hung.; 30: No. 4, 341-50(1971).

The solution of a magnetohydrodynamic system of equations for an incompressible real conducting medium is given for the instationary case. It is shown that the results of Szabó for ideal media are reobtained in the case when the hydrodynamical viscosity of the real medium tends to zero. (auth)

29126 COMPLEX LAMELLAR PSEUDOSTATIONARY HYDROMAGNETIC FLUID FLOWS. Murthy, D. N. (Nagarjunasagar Engineering Coll., Hyderabad, India). Tensor; 23: No. 1, 88-90 (Jan 1972).

An electrically conducting, ideal, incompressible fluid, devoid of viscosity and thermal conductivity is assumed. It is assumed further that the mean electric charge is zero, so that the medium is essentially neutral, that the displacement currents may be neglected, and that the electric conductivity of the fluid is infinite. (M.H.R.)

29127 MAGNETOHYDRODYNAMIC FLOW OF AN INCOMPRESSIBLE FLUID BETWEEN TWO CONCENTRIC CYLINDERS Jaumotte, A. L.; Hirsch, C.; Dequin, D. (Univ., Brussels). Bull. Cl. Sci., Acad. Roy. Belg.; 56: No. 7, 654-60(1970). (In French).

An experimental investigation is reported of an MHD mercury flow between two concentric circular cylinders with isolated walls. Head losses and voltage measurements are compared with theoretical predictions for large Hartmann numbers with an excellent agreement. (auth)

PHYSICS (HIGH-ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 28237.

29128 (LBL-40) PHYSICS ANNUAL REPORT, JULY 1970-JUNE 1971. (California Univ., Berkeley. Lawrence Berkeley Lab.). 1971. Contract W-7405-eng-48. 123p. Dep. NTIS.

Research progress is outlined in the fields of experimental and theoretical high-energy physics, health physics, computing and data handling, and accelerator technology. Publications issued during the period are listed. (W.H.K.)

29129 PAST AND FUTURE OF HIGH-ENERGY PHYSICS. Weisskopf, Victor F. (Massachusetts Inst. of Tech., Cambridge). pp XIX.1-10 of Proceedings of the 8th International Conference on High-Energy Accelerators, CERN 1971. /Blewett, M. Hildred (ed.). Geneva; European Organization for Nuclear Research (1971).

From eighth international conference on high energy accelerators; Geneva, Switzerland (20 Sep 1971).

The historical development of atomic, nuclear, and high-energy physics is briefly discussed, and the evolution of the high-energy accelerator is outlined. Topics for future high-energy research are mentioned including the possible internal structure of the electron, the quark problem, the substructure of the proton, and the relation of particle physics with astronomy. (W.H.K.)

Electromagnetic

Refer also to abstract 29732.

29130 (CONF-710452-1) RESULTS FROM STORAGE RINGS. Note No. 319. Borgia, B. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 25 May 1971. 41p. Dep. NTIS (U. S. Sales Only).

From Conference on elementary particle physics; Lancaster, England (5 Apr 1971).

The historical development of research using storage rings is discussed covering quantum electrodynamics validity, vector meson dominance, and new aspects and preliminary results at high energies. There are 42 references. (J.F.P.)

29131 (JINR-E1-6276) SCALING LAW FOR THE PROTON FORM FACTORS. Bilenkaya, S. I.; Bilenky, Kazarinov, Yu. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Mar 1972. 7p. Dep. NTIS (U. S. Sales Only).

All the available data on the e-p cross sections are analyzed to check the validity of the scaling law. The results of recent measurements of the Bonn group are analyzed separately. The requirement for the form factors G_M and G_E to be equal at the point $q^2 = -4M_p^2$ is imposed. The data are also analyzed in the case when this constraint is not imposed. The analysis shows that within errors, over the whole experimentally studied region of q^2 the ratio $\mu G_E/G_M$ does not deviate from unity. (auth)

29132 (NP-19230) MUON PAIR PRODUCTION BY ELECTRON-POSITRON COLLISIONS IN THE GeV REGION. Note No. 336. Barbiellini, G.; Borgia, B.; Ceradini, F.; Conversi, M.; Grianti, F.; Grilli, M.; Paoluzi, L.; Santonico, R.; Spillantini, P.; Visentin, R. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 29 Sep 1971. 14p. Dep. NTIS (U. S. Sales Only).

The cross section for electron-positron annihilation into muon pairs was measured at "Adone", simultaneously with that of wide angle Bhabha scattering (WAS), at total energies of the colliding beams up to 2.1 GeV. The results, based on a total of 400 annihilation events and 7192 associated WAS events, agree with the predictions of quantum electrodynamics and exclude the existence of a "Lee-Wick heavy photon" of mass smaller than ~10 proton masses at 95% confidence level. (auth)

29133 (SLAC-140) COHERENT PHOTOPRODUCTION OF ρ MESONS FROM DEUTERIUM. Overman, Irving D. (Stanford Linear Accelerator Center, Calif.). Nov 1971. Contract AT(04-3)-515. 74p. Dep. NTIS.

Measurements of the forward differential cross section for the process $\gamma + d \rightarrow \rho^0 + d$ were made at Stanford Linear Accelerator Center using a missing mass spectrometer. The recoil deuterons were detected by pulse height and time-of-flight. Measurements were made at 6, 12, and 18 GeV and covered a momentum transfer range of $-0.15 > t > -1.4$ $(GeV/c)^2$. The results were interpreted on the basis of the Glauber model and found to be in excellent agreement. From this analysis values for both the total and differential cross section for the reaction $\rho^0 + N \rightarrow \rho^0 + N$ were extracted in rough agreement with the quark model. The value of σ_T obtained in this experiment was used together with previous hydrogen photoproduction data and with total photoabsorption cross section measurements to determine $\gamma_\rho^2/4\pi$. The results of these two calculations are in disagreement well outside experimental errors and indicate the vector dominance model does not describe all physical processes relating to photon-hadron interactions. (auth)

29134 COINCIDENCE MEASUREMENTS OF SINGLE K^+ ELECTROPRODUCTION. Brown, C. N. (Harvard Univ., Cambridge, Mass.); Canizares, C. R.; Cooper, W. E.; (and others). Phys. Rev. Lett.; 28: No. 16, 1086-9(17 Apr 1972).

The reactions $e^- + p \rightarrow e^- + K^+ + \Lambda$ and $e^- + p \rightarrow e^- + K^+ + \Sigma^0$ were studied by detecting the final electron and kaon in coincidence. Data are presented in the region of virtual-photon mass squared from -0.18 to -1.2 GeV^2, virtual-photoproduction center-of-mass energy from 1.85 to 2.60 GeV, and virtual-photoproduction center-of-mass angle from 0 to 28°. The Σ^0/Λ ratio tends to be smaller than in photoproduction, and the data suggest large scalar production of the $K^+\Lambda$ final state. (auth)

29135 PHOTOPRODUCTION OF $K^+\Lambda^0$ AND $K^+\Sigma^0$ FROM HYDROGEN AT CONSTANT MOMENTUM TRANSFER t BETWEEN 1.05 AND 2.2 GeV. Feller, P.; Menze, D.; Opara, U.; Schulz, W.; Schwille, W. J. (Univ., Bonn). Nucl. Phys.; B39: No. 1, 413-20(1972).

For the reaction $\gamma p \rightarrow K^+\Lambda^0$ the differential cross section was measured at $t = -0.147$ GeV^2 ($\theta_{C.M.} = 26.5 \pm 3.5°$) and photoenergies between 1.05 and 2.2 GeV and for the reaction $\gamma p \rightarrow K^+\Sigma^0$ at $t \approx -0.17$ GeV^2 ($\theta_{C.M.} = 28.5 \pm 3.5°$) and photoenergies between 1.3 and 2.2 GeV. For this four momentum transfer the differential cross section of $K^+\Lambda^0$ photoproduction has a surprising steep increase above threshold and stays nearly constant up to 2.2 GeV. The $K^+\Sigma^0$ cross section increases from 1.3 to 1.56 GeV and goes down gradually at higher energies. (auth)

29136 BACKWARD PRODUCTION OF VECTOR MESONS IN INELASTIC ELECTRON SCATTERING. Driver, C. (Deutsches Elektronen-Synchroton, Hamburg); Heinloth, K.; Hoehne, K.; (and others). Nucl. Phys.; B39: No. 1, 106-18(1972).

Electroproduction of the vector mesons ρ^0 and ω on protons at backward angles was investigated by measuring the scattered electron and the recoiling proton in coincidence. The differential cross section was determined as a function of W, q^2, $u-u_{min}$ and φ_V. (auth)

29137 ELECTROPRODUCTION OF π^0-MESONS IN THE SECOND-RESONANCE REGION. Shuttleworth, W. J. (Univ. of Manchester, Eng.); Dickinson, B.; Ibbotson, M.; (and others). Lett. Nuovo Cim.; 3: No. 12, 497-502(17 Mar 1972).

The results are reported of an experiment on the electroproduction of single π^0-mesons in the region of the second pion-nucleon resonance using a 4.0-GeV extracted beam. The results were obtained with the mean four-momentum transfer squared to the pion-nucleon system $k^2 = 0.4$ and $k^2 = 0.6$ $(GeV/c)^2$ and the mass of the pion-nucleon system W from 1.385 to 1.545 GeV/c^2. The virtual photoproduction differential cross sections were determined. The data are compared with the fixed-t dispersion theory calculations. (L.B.S.)

29138 POLARIZATION OF RECOIL NUCLEONS FROM SINGLE PION PHOTOPRODUCTION: EXPERIMENTAL METHODS AND RESULTS. Brinckmann, Paul (Univ., Bonn). Springer Tracts Mod. Phys.; 61: 137-66(1972).

Experiments on recoil nucleon polarization in the reactions $\gamma + p \rightarrow \pi^0(\pi^+) + p(n)$ below 1.2 GeV are reviewed, and typical experimental techniques involved are discussed. The significance of polarization measurements within the framework of a theoretical analysis of the photoproduction reactions especially in the resonance region is shown. (J.F.P.)

29139 DEEP INELASTIC ELECTRON-NUCLEON SCATTERING. Drees, J. (Univ., Bonn). Springer Tracts Mod. Phys.; 60: 107-37(1971).

A review is given of the present experimental situation and theoretical attempts to understand the data in the deep inelastic region of high four-momentum transfer and high invariant mass of the hadronic final state. Electron-proton and electron-deuteron inelastic scattering and comparison with muon scattering is discussed. The parton model, relation with resonance excitation and nondiffractive models, and Regge pole analysis are used for data interpretation. The relations with other processes are also discussed. (J.F.P.)

Weak

Refer also to abstract 28845.

29140 (AD–733542) ENERGY SPECTRA OF ELECTRONS FROM IN-FLIGHT DECAY OF VARIOUS MESONS AND BARYONS. Suh, Paul K. (Grumman Aerospace Corp., Bethpage, N. Y. Research Dept.). Oct 1971. 56p. (RE–416). NTIS.

Concise analytical energy spectra of electrons produced from decaying mesons and baryons in free flight are determined. (auth) (NTIS)

29141 (COO–3065–2) EXPERIMENTAL STUDY OF K^+ DECAY. Chiang, I-Hung (Rochester Univ., N. Y. Dept. of Physics and Astronomy). 1971. Contract AT(11-1)-3065. 111p. Dep. NTIS.

Thesis.

An array of optical spark chambers was used to study the decay of the 1.84-GeV/c K^+ in flight. The experiment was performed using a partially separated K^+ beam at the Argonne National Laboratory Z.G.S. Accelerator. The apparatus was sensitive to all decay modes, and had a high detection efficiency for the two γ rays from the π^0. The six principal decay channels of the K^+ were observed in a relatively bias-free fashion. A total of 90,000 events having K^+ decays originating in a specified fiducial region were sorted among these modes. $K_{\mu 3}$ and $K_{\mu 3}$ decays were separated by kinematical analysis using events in which both π^0 γ rays were observed. The branching ratios we obtained are: $K_{\pi 2}$ = (63.24 ± 0.44)%, τ = (5.56 ± 0.20)%, $K_{\pi 3}$ = (3.33 ± 0.16)%, $K_{\mu 2}$ = (21.18 ± 0.28)%, τ' = (1.84 ± 0.06)%, and K_{e3} = (4.86 ± 0.10)%. Also the 2γ opening angle distribution was studied in the K^+_{e3} data. The value $\lambda_+ = 0.042 \pm 0.015$ was found. Using this value of λ_+ and the $K_{\mu 3}$ to K_{e3} branching ratio, assuming $\lambda_- = 0$, $\xi(0) = -0.11^{+0.38}_{-0.36}$ was obtained. (auth)

29142 (IFVE–ORE–71-25) PASSING OF HIGH-ENERGY MUONS THROUGH THE STEEL SHIELDING. Drugachenok, S. A.; Kimel, L. R.; Krupnyi, G. I.; Lebedev, V. N.; Sidorin, V. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1971. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

An experimental investigation of high-energy muons passing through the steel shielding is presented. The attenuation lengths of muons were obtained; the experimental data are compared with calculations. (auth)

29143 CURRENT STATUS OF THE LEPTON g FACTORS. Rich, Arthur; Wesley, John C. (Univ. of Michigan, Ann Arbor). Rev. Mod. Phys.; 44: No. 2, 250-84(Apr 1972).

The past three years have seen new measurements of the g-factor anomalies of the free leptons ($e^{\pm}$,$\mu^{\pm}$). At the same time there have been several major theoretical advances including a quantum electrodynamic calculation of the sixth-order coefficient of the electron anomaly. These recent developments are reviewed in detail. A historical overview of g-factor measurements and their interpretation since the early days of quantum theory is presented. Several experiments which are currently being attempted but which have not yet yielded results of high precision are discussed, and an attempt is made to predict the most likely course of g-factor research in the near future. An extensive bibliography and tables summarizing both historical events and current work are included. (auth)

29144 MEASUREMENT OF THE ELECTRON ASYMMETRY PARAMETER IN THE DECAY OF POLARIZED Σ^- HYPERONS. Ellis, R. J. (Oxford Univ.); Blair, I. M.; Taylor, A. E.; (and others). Nucl. Phys.; B39: No. 1, 77-105(1972).

A measurement made at the Rutherford Laboratory of the electron asymmetry parameter in the decay $\Sigma^- \rightarrow ne^-\bar{\nu}$ using counters and wire spark chambers is reported. Polarized Σ^- was produced in the reaction $\pi^-p \rightarrow \Sigma^-K^+$ at an incident momentum of 1.13 GeV/c. The mean Σ^- polarization for detected events was $P_{\Sigma^-} = -0.32 \pm 0.11$. The value obtained for the electron asymmetry parameter was $\alpha_e = +0.39^{+1.3}_{-1.3}$ based on 43 events. This yields a value for the ratio of axial vector to vector coupling constants for this decay of $g_A/g_V = -0.4^{+0.9}_{-1.1}$. The Cabibbo prediction for this decay is +0.3. The sign convention that g_A/g_V for neutron beta decay is −1.23 is used. (auth)

29145 MEASUREMENT OF THE β-PARAMETER IN THE CHARGED NONLEPTONIC DECAY OF THE Λ^0 HYPERON. Cleland, W. E. (CERN, Geneva); Conforto, G.; Eaton, G. H.; (and others). Nucl. Phys.; B40: 221-54(1972).

For the β-parameter in the decay $\Lambda^0 \rightarrow \pi^-p$ the value $\beta = -0.094 \pm 0.060$ was obtained. This value agrees with the theoretical prediction based on T-invariance and the $|\Delta I| = \frac{1}{2}$ rule, taking into account the effects of final state interactions. The Λ^0 were produced by 1.03 and 1.06 GeV/c π^- in a liquid hydrogen target, and the polarization of the recoil proton was measured in a carbon-plate spark chamber polarimeter. The triggering conditions were successfully designed to select events of the configuration best adapted to the determination of the β-parameter. (auth)

Strong (Baryon-induced)

Refer also to abstracts 28800, 28834, and 29491.

29146 (CEA-CONF–1960) MEDIUM ENERGY HADRON DYNAMICS: TWO-BODY AND QUASI-TWO-BODY REACTIONS. Barloutaud, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1971]. 74p. (CONF-710609–12). Dep. NTIS (U. S. Sales Only).

From International conference on elementary particles; Amsterdam, Netherlands (30 Jun 1971).

A review is given for exotic processes and two-body and quasi-two-body line-reversed nondiffractive strong interactions. (J.F.P.)

29147 (DESY–72/9) PIONIZATION IN PP INTERACTIONS AT 12 AND 24 GeV/c. Mueck, H. J.; Schachter, M.; Selonke, F.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Feb 1972. 9p. Dep. NTIS (U. S. Sales Only).

Inclusive π^- and π^+ distributions in the region of small longitudinal c.m. momenta, from pp interactions at 12 and 24 GeV/c, are presented and compared with CERN-ISR data. Interesting scaling and factorization properties are found. The extent to which the observed behavior can be interpreted as evidence for pionization is discussed. (auth)

29148 $K^+K^-\pi^+\pi^-$ AND $K^+K^-\pi^+\pi^-\pi^0$ FINAL STATES IN $\bar{p}p$ ANNIHILATIONS AT 2.2 GeV/c. Kwak, N.; Mall, G. H.; Manweiler, J. E.; Stump, R. (Univ. of Kansas, Lawrence). Phys. Rev., D; 5: No. 5, 1059-63(1 Mar 1972).

Approximately 7200 four-prong annihilations of 2.2-GeV/c antiprotons in hydrogen were measured. About 200 of the events contained charged kaon pairs. The cross sections for the final states $K^+K^-\pi^+\pi^-$ and $K^+K^-\pi^+\pi^-\pi^0$ were measured as 192 ± 26 and 488 ± 50 μb, respectively. The main feature of the reactions is the production of K*(890), ρ(760), and ω(783). (auth)

29149 ISOBAR PRODUCTION AND ELASTIC SCATTERING IN p–p INTERACTIONS FROM 6 TO 30 GeV/c. Edelstein, R. M. (Carnegie-Mellon Univ., Pittsburgh); Carrigan, R. A. Jr.; Hien, N. C.; (and others). Phys. Rev., D; 5: No. 5, 1073-96(1 Mar 1972).

Differential cross sections were measured for nucleon-isobar production and elastic scattering in p–p interactions from 6.2 to 29.7 GeV/c in the laboratory angle range $8 < \theta_{sc} < 265$ mrad. N*'s at 1236, 1410, 1500, 1690, and 2190 MeV were observed. Computer fits to the mass spectra under varying assumptions of resonance and background shapes show that conclusions on t and s dependence are only slightly affected despite typical variations in absolute normalization of ±35%. Logarithmic t slopes in the small-|t| range are ~15 $(GeV/c)^{-2}$ for the N*(1410), ~5 $(GeV/c)^{-2}$ for the N*'s at 1500, 1690, and 2190 MeV, and ~9 $(GeV/c)^{-2}$ for elastic scattering. Also for the small-|t| data, cross sections for N*'s at 1410, 1500, 1690, and 2190 MeV and for elastic scattering vary only slightly with P_{inc} consistent with the dominance of Pomeranchuk exchange and with diffraction dissociation. A fit of N*(1690) total cross sections to the form $\sigma \propto P^{-n}$ gives $n = 0.34 \pm 0.06$, while for elastic scattering $n = 0.20 \pm 0.05$. For the N*(1690) the effective Regge trajectory has the slope $\alpha'_{eff}(0) = 0.38 \pm 0.17$. When compared with N* production in π^-, K^-, and $\bar{p}$ beams these data also agree with approximate factorization of the Pomeranchuk trajectory. N*(1236) cross sections are consistent with other measurements at similar momenta. For $-t > 1$ $(GeV/c)^2$, elastic scattering cross sections decrease approximately as P_{inc}^{-2}, and they and N*(1500)- and N*(1690)-production cross sections have t slopes consistent with 1.6 $(GeV/c)^{-2}$. (auth)

29150 STUDY OF ELASTIC PROTON–NEUTRON SCATTERING BY MEANS OF PROTON–DEUTERON SCATTERING AT 24.0 GeV/c. Amaldi, U.; Biancastelli, R.; Bosio, C.; Matthiae, G. (Istituto Superiore di Sanita, Rome. INFN, Rome). Nucl. Phys.; B39: No. 1, 39-60(1972).

Measurements of proton-deuteron scattering were performed using an incident 24.0 GeV/c proton beam. Momentum-loss spectra of forward-scattered protons were measured by a single-arm spectrometer over a range of proton angles from 13 to 107 mr. The contributions to the proton spectra of single and double scattering can be separated experimentally, thus allowing estimates of proton-neutron elastic cross sections to be deduced from the data over a range of four-momentum transfer squared, |t|, from 0.1 to 5.8 GeV^2. Elastic p–d scattering, in which the proton and deuteron were detected in coincidence, was also measured over a range of |t| from 0.6 to 1.8 GeV^2.

29151 STUDY OF THE REACTIONS $p + p \rightarrow p + (p\pi^+\pi^-)$ AND $p + d \rightarrow d + (p\pi^+\pi^-)$ AT 28 GeV/c. Panvini, R. S. (Brookhaven

National Lab., Upton, N. Y. Vanderbilt Univ., Nashville); Waters, J. W.; Morris, T. W. Nucl. Phys.; B39: No. 1, 538-46(1972).

The production of low-mass ($p\pi^+\pi^-$) systems at small t (squared four-momentum transfer) was studied in the reaction p + p → p+ ($p\pi^+\pi^-$) and p + d → d+ ($p\pi^+\pi^-$) at 28 GeV. Comparisons of these inelastic reactions with elastic pp and pd scattering reveal the "elastic-like" nature of ($p\pi^+\pi^-$) production. The results provide evidence that ($p\pi^+\pi^-$) production in pp reactions is dominated by isospin zero exchange. (auth)

29152 ISOBAR PRODUCTION AND DIFFRACTION DISSOCIATION IN $pn \rightarrow pp\pi^-$ AT 7.0 GeV/c. Yekutieli, G.; Yaffe, D.; Shapira, A.; (and others) (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; B40: 77-97(1972).

The reaction $pn \rightarrow pp\pi^-$ at 7.0 GeV/c is studied in a pd experiment. Observations on isobar production and low-mass enhancement are reported. The $I = \frac{1}{2}$ isobars and the low-mass enhancement produced at the neutron vertex are discussed in terms of the diffraction dissociation plus duality model. (auth)

29153 REACTION $\bar{p}d \rightarrow \Lambda^0$ + ANYTHING AT 1.9 TO 2.90 GeV/c: DOUBLE SCATTERING EFFECTS AND THE MISSING MASS SPECTRUM. Oh, B. Y.; Smith, G. A. (Michigan State Univ., East Lansing). Nucl. Phys.; B40: 151-6(1972).

The cross section and momentum dependence of Λ's produced in the reaction $\bar{p}d \rightarrow \Lambda$ + anything was studied at 1.09 to 2.90 GeV/c incident momentum. It is found that this reaction is primarily produced in double scattering collisions within the deuteron. This, plus the wide range of incident momenta available, demonstrates that the missing mass spectrum is inconsistent with the hypothesis of a resonance at 2.06 GeV, as suggested by Camerini et al. in a similar experiment at 1.25 to 1.67 GeV/c. (auth)

29154 HYPERON–NUCLEON INTERACTION. de Swart, J. J.; Nagels, M. M.; Rijken, T. A.; Verhoeven, P. A. (Univ., Nijmegen, Netherlands). Springer Tracts Mod. Phys.; 60: 138-203 (1971).

In this review of experiment any theory for hyperon–nucleon interactions channels and thresholds, SU(3) symmetry for baryon–baryon scattering, the number of independent amplitudes, relativistic, center-of-mass, and helicity amplitudes, the dispersion approach and analyticity domains of the partial wave scattering amplitudes are treated. Also covered are the potential approach, construction of a B–B potential, ranges of the potentials, the Schroedinger formalism for coupled channels, charge symmetry breaking, hyperfragments, interactions of the lambda hyperon with nuclear matter, and final state interactions. Other topics are Λ–N, Σ^+–p, and Σ^-–p scattering, and effective range analysis. (J.F.P.)

29155 MEASUREMENTS OF THE ASYMMETRIES IN THE DIFFERENTIAL CROSS SECTIONS FOR $\bar{p}p \rightarrow \bar{p}p$ AND $\bar{p}p \rightarrow \pi^-\pi^+$ USING POLARIZED PROTONS. Ehrlich, R. D.; Etkin, A.; Glodis, P.; (and others) (Yale Univ., New Haven). Contract AT(11-1)3075. Phys. Rev. Lett.; 28: No. 17, 1147-50(24 Apr 1972).

Measured asymmetries as a function of polar scattering angle are reported for the reactions $\bar{p}p \rightarrow \pi^-\pi^+$ and $\bar{p}p \rightarrow \bar{p}p$, using a polarized proton target. The annihilation data, obtained at a $\bar{p}$ momentum of 1.64 GeV/c, are the first asymmetry data to be collected for this channel. A fit of these data and published differential cross section data is made by a partial-wave expansion, and the results are compared with a previous analysis. The elastic scattering data, obtained at 1.64 and 2.55 GeV/c, are fitted with an eight-parameter strong-absorption model. (auth)

Strong (Meson-induced)

Refer also to abstracts 28833 and 29278.

29156 (COO–1195-216) PARTIAL WAVE ANALYSIS OF THE 3π DECAY OF THE A_3. Ascoli, G.; Brockway, D. V.; Eisenstein, L.; Ioffredo, M. L.; Hansen, J. D.; Kruse, U. E. (Illinois Univ., Urbana, Dept. of Physics). [1971]. 7p. (CONF-710609–13). Dep. NTIS.

From International conference on elementary particles; Amsterdam, Netherlands (30 Jun 1971).

The 3π decay of the A_3^- produced in the reaction $\pi^- + p \rightarrow p + \pi^+ + 2\pi^-$ at 5 and 7.5 GeV/c in a bubble chamber was studied using a partial-wave analysis method. In the A_3 mass region a significant enhancement in the 3π system for the spin parity 2^- is found. The ρπ and fπ decay modes are observed for the 2^- state. (J.F.P.)

29157 (COO–3065–4) A_1 PRODUCTION IN CHARGE EXCHANGE REACTIONS. Cohen, D.; Ferbel, T.; Katz, W.; Slattery, P.; Stone, S.; Werner, B. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). [1971]. 14p. (UR–3065-372). Dep. NTIS.

The cross section for production of events in the A_1 mass region was measured for two reactions: $\pi^+ + p \rightarrow \pi^+ + \rho^0 + p$ and $\pi^- + n \rightarrow \pi^- + \rho^- + p$. The results of these experiments, both conducted at an incident pion momentum of ~7 GeV/c, are interpreted within the framework of dual models of inelastic hadron collisions. (auth)

29158 (FRNC-TH–163) STUDY OF FINAL STATES INVOLVING AT LEAST TWO STRANGE PARTICLES IN K^-p REACTIONS AT 3,95 GeV/c. Videau, Ioana (Paris Univ. (France). Faculte des Sciences). 1971. 96p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Experiments carried out in the 2m hydrogen bubble chamber at CERN on K^-p interactions at 3.95 GeV/c are presented. The incident beam and the chamber characteristics are described in detail. The cross sections corresponding to the final states involving at least two strange particles are presented. The values are compared to those obtained with different initial momenta. The results concerning baryon resonances with strangeness S = −2 are described. It was possible to accurately determine the mass and the width of Ξ^* 1530 and to analyze Ξ baryons with masses between 1700 and 2000 MeV. Results obtained in other experiments on Ξ resonances and predictions made using the SU(3) model are presented. Values for the partial cross sections for quasi two-body reactions, Y f* and Y φ are given. The mass and the width of the f*(1515) resonance were obtained. (France)

29159 (IFVE-SEF–71-49) TOTAL CROSS SECTIONS OF π^+, K^+ AND PROTONS ON PROTONS AND DEUTERONS IN THE MOMENTUM RANGE 15 GeV/c TO 60 GeV/c. Gorin, Yu. P.; Denisov, S. P.; Donskov, S. V.; Petrukhin, A. I.; Prokoshkin, Yu. D.; Stoyanova, D. A.; Allabi, Dzh. V.; Dzhakomelli, Dzh. (Gosudar-stvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1971. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

Total cross section data are presented for protons, positive pions and positive kaons on protons and deuterons in the momentum range 15 to 60 GeV/c. (auth)

29160 (LBL–735) ENERGY DEPENDENCE OF INCLUSIVE DISTRIBUTIONS IN PION INDUCED REACTIONS. Alston-Garnjost, Margaret (California Univ., Berkeley. Lawrence Berkeley Lab.). Feb 1972. Contract W-7405-eng-48. 16p. (CONF-720206–1). Dep. NTIS.

From International conference on inclusive interactions; Davis, Ca. (4 Feb 1972).

Scaling and the effects of charge symmetries on distribution energy dependence are studied for the reactions $\pi^+ + p \rightarrow \pi^+(\pi^-)$ + anything at 3.7 to 18.5 GeV/c and $\pi^- + p \rightarrow \pi^-$ + anything at 8.05 and 18.5 GeV/c in bubble chambers. (J.F.P.)

29161 (LBL–747) HYBRID SPARK CHAMBER-BUBBLE CHAMBER EXPERIMENT TO STUDY π^-p INTERACTIONS AT 14 GeV/c; A PROGRESS REPORT. Dzierba, A.; Firestone, A.; Ford, W. T.; Gomez, R.; Oddone, P.; Peck, C. W.; Power, J.; Rosenfeld, C. (California Inst. of Tech., Pasadena); Ely, R.; Grether, D. F. (California Univ., Berkeley. Lawrence Berkeley Lab.). Mar 1972. Contract W-7405-eng-48. 8p. (CONF-720206–2). Dep. NTIS.

From International conference on inclusive interactions; Davis, Ca. (4 Feb 1972).

A progress report is made on the study of diffractive dissociation of the nucleon with high statistics and good resolution in the interaction $\pi^- + p \rightarrow \pi^- + X$. The nature of the experiment is explained, and it is shown that this experiment is a technical success. The external spectrometer triggers the bubble chamber with relative high efficiency and provides much improved resolution over bubble chamber measurements alone. (J.F.P.)

29162 MEASUREMENT OF Λ^0 MASS. Hyman, L. G. (Argonne National Lab., Ill.); Bunnell, K. O.; Derrick, M.; (and others). Phys. Rev., D; 5: No. 5, 1063-8(1 Mar 1972).

Using Λ hyperons produced by negative kaons in a helium bubble chamber, the Λ^0 mass was measured to be $M_\Lambda^0 = 1115.59 \pm 0.08$ MeV/c^2. This result is based mainly on curvature and angle measurements of the proton and π^- tracks from the Λ decay. (auth)

29163 STUDY OF THE REACTIONS $K^-n \rightarrow \pi^-\pi^-\pi^+\Lambda^0$, $K^-n \rightarrow \pi^-\pi^-\pi^+\Sigma^0$, AND $K^-n \rightarrow \pi^-\pi^-\pi^+\Lambda^0\pi^0$ AT 4.91 GeV/c. Berg, R. E.; Price, R. R.; Waters, J. W.; Webster, M. S.; Weinberg, A. (Vanderbilt Univ., Nashville). Nucl. Phys.; B39: No. 1, 509-24(1972).

The cross sections for these reactions and the cross sections of resonances produced in them were measured. The production of $Y^{*\pm}(1385)$, $\rho^0(765)$, and $f^0(1260)$ is observed in the first reaction; $\rho^0(765)$ in the second; $Y^{*-,0}(1385)$, $\omega^0(784)$, $B^-(1235)$, probably $\rho^{0,-}(765)$, and an enhancement interpreted to be the $J^P = \frac{1}{2}^-$ $\Sigma^0(1750)$ in the third. Single particle longitudinal momentum dis-

tributions and average values of transverse momentum are presented. The observed single particle production angular distributions show good qualitative but not quantitative agreement with the Reggeized multiperipheral model of Chan, Loskiewicz, and Allison. Strong disagreement was found between the amounts of observed resonance production and the results of the multiperipheral model of Plahte and Roberts that is based on the models of Chan et al. and Veneziano. However, isospin effects were included only in an approximate manner. (auth)

29164 $\Delta^{++}\eta$ AND $\Delta^{++}X^0$ PRODUCTION IN π^+p INTERACTIONS AT 5.45 GeV/c AND $\eta-X^0$ MIXING. Bloodworth, I. J.; Jackson, W. C.; Prentice, J. D.; Yoon, T. S. (Univ. of Toronto). Nucl. Phys.; B39: No. 1, 525-37(1972).

The production of η and X^0 mesons was investigated in four and six prong events from π^+p interactions at 5.45 GeV/c. The cross sections for the quasi two body states $\Delta^{++}\eta$ and $\Delta^{++}X^0$ were found to be 0.076 ± 0.013 mb and 0.017 ± 0.006 mb respectively. A comparison of the matrix elements for these reactions yields an $\eta-X^0$ mixing angle different from that predicted by the quadratic mass formula by about 20°, but within 6° of the linear mass formula result. (auth)

29165 APPLICATION OF THE DOUBLE REGGE POLE EXCHANGE MODEL TO 8 GeV/c π^+p AND 16 GeV/c π^-p INTERACTIONS. Bartsch, J.; Honecker, R. (Technische Hochschule, Aachen). Nucl. Phys.; B39: No. 1, 175-88(1972).

The double Regge pole exchange model of Chan, Kajantie and Ranft is applied to reactions involving three uncorrelated final particles in 8 GeV/c π^+p and 16 GeV/c π^-p interactions. Restricting the analysis to the central region of the Dalitz plot the exchange of various trajectory pairs is studied. It is found that the exchange of meson trajectories is favored against the exchange of the pomeron. The results are consistent with some well known characteristics of corresponding two body processes. (auth)

29166 STUDY OF THE $K^{*0}\Lambda$ AND $K^{*0}\Sigma^0$ FINAL STATES FROM π^-p INTERACTIONS AT 3.9 GeV/c. Abramovich, M.; Chaloupka, V.; Chung, S. U.; (and others) (CERN, Geneva). Nucl. Phys.; B39: No. 1, 189-200(1972).

A study of $\pi^-p \to K^*\Lambda$ and $\pi^-p \to K^*\Sigma^0$ at 3.9 GeV/c indicates that the main features of both reactions can be interpreted in terms of simple exchange processes, the first involving both natural and unnatural exchange, the second showing evidence for natural parity exchange only. (auth)

29167 STUDY OF THE REACTIONS $K^-n \to \pi^-\pi^- p\,\overline{K}^0$, $K^-n \to \pi^-\pi^- p\,\overline{K}^0\pi^0$, AND $K^-n \to \pi^-\pi^-\pi^+\overline{K}^0n$ AT 4.91 GeV/c. Price, R. R.; Berg, R. E.; Waters, J. W.; Webster, M. S.; Weinberg, A. (Vanderbilt Univ., Nashville). Nucl. Phys.; B39: No. 1, 572-86(1972).

Resonance production in the above reactions containing a proton in the final state is characterized primarily by the production of $K^{*-}(890)$. The events with a final state neutron are characterized by the production of either $K^{*-}(890)$ or $\Delta^-(1236)$, but very little double resonance production. Cross sections are presented. Exponential slopes for the momentum-transfer distributions of the $K^{*-}(890)$ and $\Delta^-(1236)$ were determined and found to be much smaller than for elastic scattering. For the $\pi^-\pi^-p\overline{K}^0$ events the spin density matrix elements for the decay of the $K^{*-}(890)$ in the Jackson frame imply alignment. Single particle longitudinal momentum distributions and average values of transverse momentum are presented. The single particle production angular distributions of all three reactions were compared with the results of the Reggeized multiperipheral model of Chan, Loskiewicz, and Allison (CLA) modified to include resonance production. Good qualitative agreement was found. The data from the $\pi^-\pi^-p\overline{K}^0$ events were also compared with a multiperipheral model of Plahte and Roberts that is based on the CLA and Veneziano models. (auth)

29168 STUDY OF THE REACTION $K^-p \to \overline{K}N\pi$ AT 4.2 GeV/c. Tiecke, H. G. J. M. (Univ. of Nijmegen, Netherlands); Crijns, F. J. G. H.; Heinen, P. M.; (and others). Nucl. Phys.; B39: No. 1, 596-615(1972).

Results are presented on effective-mass distributions, differential cross sections and longitudinal c.m. momentum distributions for the channels $K^-p \to K^-p\pi^0$, $\overline{K}^0p\pi^-$ and $K^-\pi^+n$, obtained from a sample of approximately 28,000 inelastic two-pronged interactions at 4.2 GeV/c incident momentum. The results are in satisfactory agreement with the prediction of a generalized Veneziano-model corrected for (non-dual) π- and pomeron exchange. For the channel $K^-p\pi^0$ pomeron exchange contributes about 20% of the cross section. In the channel $K^-\pi^+n$ the dual, pion and pomeron contributions are responsible for resp. 15%, 65% and 20% of the total cross section. Results on total and differential cross sections and spin-density matrix elements for the quasi two-body reactions $K^-p \to K^{*-}(890)p$ and $K^-p \to K^{*0}(890)n$ are also presented. These results are compared with single Regge-pole exchange model predictions. The reaction mechanism of $K^{*-}(890)$ production is dominated by the $\omega(\phi)$ trajectory exchange with some admixture of π-exchange. The mechanism for $K^{*0}(890)$ production is dominated by π-exchange with some admixture of (A_2) trajectory exchange. (auth)

29169 INTERACTIONS OF 60 GeV π^- MESONS WITH PROTONS AND NUCLEI. Dalkhazhav, N.; Shabratova, G. S.; Tolstov, K. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys.; B40: 190-8(1972).

Interactions of 60 GeV/c π^- mesons with nucleons, light (C, O) and heavy (Ag, Br) nuclei were investigated using emulsions of two types: the usual (Br-2) emulsion in which about $\frac{1}{3}$ of the interactions occur on light nuclei and emulsion enriched by (CH_2ON). In the latter type the fraction of interactions with free protons increases to 0.12 and with light nuclei to 0.5. It is shown that the mean multiplicity of charged particles in inelastic collisions as a function of energy follows the $E^{0.36\pm0.04}$ law. The characteristics of the interactions on C, O and Ag, Br were studied, and also the coherent interactions of pions with the emulsion nuclei. (auth)

29170 DOMINANCE OF ISOSPIN ZERO EXCHANGE IN $\pi^\pm p \to \pi(N\pi)$ AT 16 GeV/c AND PRODUCTION BY IT OF A LOW MASS ($N\pi$) ENHANCEMENT. Boesebeck, K. (Technische Hochschule, Aachen); Deutschmann, M.; Graessler, H.; (and others). Nucl. Phys.; B40: 39-44(1972).

An isospin analysis was made of the production of ($N\pi$) states in the reactions $\pi^\pm p \to \pi(N\pi)$ at 16 GeV/c. The three independent amplitudes and their three interference terms were determined as functions of the ($N\pi$) mass. It is found that at 16 GeV/c isospin-zero exchange is the dominant process, and isospin-one occurs much less frequently, mostly producing the $I = \frac{3}{2}$ $\Delta(1236)$ isobar. Interference effects do not seem very important. The $I = \frac{1}{2}$ ($N\pi$) mass spectrum due to isospin-zero exchange presents a broad enhancement from 1.1 to 1.8 GeV, with a broad maximum between 1250 and 1500 MeV. The N* isobars found by phase shift analyses at 1470, 1520, 1690, etc. MeV cannot account for the whole enhancement observed and in particular for its low-mass part. These results are consistent with the interpretation that diffractive phenomena are important at low $N\pi$ masses and may cause mass enhancements not revealed by phase-shift analyses. (auth)

29171 FORMATION OF THE $\Sigma(1760)$ IN THE REACTION $K^-p \to K^-p\pi^0$. A FURTHER STUDY. Barletta, W. A. (Univ. of Chicago). Nucl. Phys.; B40: 45-64(1972).

The reaction chain $K^-p \to \Sigma(1760) \to \Lambda(1520)\pi^0$, $\Lambda(1520) \to K^-p$ was studied to yield a momentum dependent description of the formation of the $\Sigma(1760)$, taking into account non-resonant amplitudes. By the use of the helicity formalism these amplitudes were assigned a spin parity of $\frac{3}{2}^+$ and are found to contribute approximately 4% to the $\Lambda(1520)$ production cross section. In addition, the production of $\overline{K}^*(890)$ and $\Delta(1236)$ in the $K^-p\pi^0$ final state and their effect upon $\Lambda(1520)$ production is discussed. (auth)

29172 STUDY OF LAMBDA PRODUCTION IN 10 GeV/c K^-p INTERACTIONS. Bartsch, J. (Technische Hochschule, Aachen); Kraus, G.; Speth, R.; (and others). Nucl. Phys.; B40: 103-24 (1972).

Lambda production is studied in K^-p interactions at 10.1 GeV/c, where the dominant reaction is $K^-p \to \Lambda$ + pions. General characteristics such as the distributions of the double differential cross section in the lab system, of the variable $x = p_L^*/p_{max}^*$, of $p_\perp^*$ and of the missing mass to the lambda are presented. Total cross sections for Λ production and for the various channels are given. Differential cross sections $d\sigma/dt$, $d\sigma/dt'$ and $d\sigma/du'$ are presented. Forward and backward peaks are observed in the $d\sigma/dt'$ and $d\sigma/du'$ distributions, respectively. It is found that the exponential slope of these distributions decreases with increasing missing mass to the lambda and, for $d\sigma/dt'$, also for increasing multiplicity in the final state. The polarization of the lambdas is studied as a function of multiplicity, p_L^*, ($\Lambda\pi^\pm$) effective mass, t' and u'. The forward lambdas show negative polarization, while the strongly backwards ones have polarization consistent with zero. Resonance production in the reactions $K^-p \to \Lambda\pi^+\pi^-$ and $K^-p \to \Lambda\pi^+\pi^-\pi^0$ is studied and cross sections for ten quasi two-body reactions are given. The reactions $K^-p \to \Lambda\pi^+\pi^-$, $K^-p \to \Lambda K^+K^-$ and $K^-p \to \Lambda p\overline{p}$ are studied and it is found that the lambdas are produced backwards in the first two reactions and forwards in the third. (auth)

Particle Interactions and Properties (Theoretical)

Refer also to abstract 29225.

General

Refer also to abstracts 29128, 29129, 29368, and 29865.

29173 (DESY-72/12) EXPERIMENTAL DETERMINATION OF FUNCTIONS. Yellin, S. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Mar 1972. 39p. Dep. NTIS (U. S. Sales Only).

A general method is given by which one may correct for a bias that results when the maximum likelihood method is used with a sample of finite size. The application to the problem of unfolding an unknown function from experimental data is discussed. A method is given by which one may determine if data require the existence of structure in a unknown function. This technique unfolds a function from data without parameterizing; i.e., without assuming that the function is a known function with unknown parameters. If, on the other hand, one is able to reliably parameterize an unknown function, but does not know the functional form of the background to the measurement, a method is supplied for making the foreground-background separation without parameterizing the background. A method is given for improving the effective resolution of experimental measurements. This method is a generalization of "bremsstrahlung end-point subtraction," a common technique in high energy photon physics. (auth)

29174 (JINR-E2-6267) COMPOSITENESS AND VANISHING OF RENORMALIZATION CONSTANTS. Passi, J. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). Mar 1972. 13p. Dep. NTIS (U. S. Sales Only).

It is demonstrated within the framework of a model field theory that vanishing of wavefunction and vertex function renormalization constants are not sufficient conditions to make an elementary particle equivalent to a three-particle bound state. It is noticed that the Jin-McDowell cancellation for the three-particle bound state does not hold good. (auth)

29175 (NP-19168) REPORT OF THE YEAR 1969/70. (Statens Rad for Atomforskning, Stockholm (Sweden)). 1971. 132p. (In English and Swedish). Dep. NTIS (U. S. Sales Only).

Brief notes are given on atomic scientific research in Sweden. Awarded grants 1969/70 are listed. The Swedish participation in the European organization for nuclear research (CERN) and in the Nordic Institute for Theoretical Atomic Physics in Copenhagen is summarized. (Sweden)

29176 (RLO-1388-623) FIRST AND SECOND FACTORIZATION IN A DUAL MULTIPARTICLE THEORY WITH NONLINEAR TRAJECTORIES. Yu, S.; Baker, M. (Washington Univ., Seattle. Dept. of Physics); Coon, D. D. (Pittsburgh Univ., Pa. Dept. of Physics). [1971]. Contracts AT(45-1)-1388; AT(11-1)-1764; AT(30-1)-3829. 45p. Dep. NTIS.

The N-point tree graphs of a dual resonance theory with nonlinear trajectories are factorized. The factorization procedure applies equally well with the external lines on or off the mass shell. The particle spectrum of the theory is found to have a degeneracy of approximately ϑ^l for the l^{th} level. Since the trajectory is logarithmic, the asymptotic density of levels grows only as some power of the mass. The techniques used in the first factorization are applied to the second factorization to arrive at an amplitude for processes involving two external particles with nonzero spins. Two sets of linear dependence relations among the amplitudes obtained by factorization are proven. (auth)

29177 (RLO-2041-67) SOME REMARKS ABOUT THE DIFFRACTIVE EXCITATION MODEL. Hwa, Rudolph C. (Oregon Univ., Eugene). [Feb 1972]. Contract AT(45-1)-2230. 20p. Dep. NTIS.

The diffractive excitation model is reviewed covering correlations between proton and pion spectra, two-particle distributions, exclusive multiplicity, and distribution at wee-x. (J.F.P.)

29178 (UH-511-95-71) NEW DEPARTURES IN PARTICLE THEORY. Lectures at the Institute of Physics, National Tsing Hua University, Hsinchu, Republic of China, January 4-15, 1971. Tuan, S. F. (Hawaii Univ., Honolulu. Dept. of Physics and Astronomy). Mar 1971. 82p. Dep. NTIS.

The topics covered by these lectures are meson spectroscopy, the conjecture of T. D. Lee on nonchiral SU(2) × SU(2) and the baryon spectrum, conjectures of R. P. Feynman on Z^* baryons, the status of CP effects, CP and the ideas of mismatch and the a^1 particle model, the W meson and chimerons, and outstanding unsolved problems. (J.F.P.)

29179 INTERNAL CO-ORDINATES FOR A SYSTEM OF FERMIONS. Peres, A. (Israel Inst. of Tech., Haifa). Lett. Nuovo Cim.; 3: No. 14, 611-12(1 Apr 1972).

The difficulty which arises when one attempts to antisymmetrize the wave function of a system of fermions and, at the same time, to separate the center-of-mass motion from the internal structure is considered. A simple solution of the problem is given, which can be generalized to include spin and isospin. (L.B.S)

29180 REVIEW OF PARTICLE PROPERTIES. Soeding, Paul (DESY, Hamburg); Bartels, Jochen; Barbaro-Galtieri, Angela; (and others). Phys. Lett.; 39B: No. 1, i-xvi; 1-145 (Apr 1972).

This review of the properties of leptons, mesons, and baryons is an updating of Review of Particle Properties, Particle Data Group [Rev. Mod. Phys. 43, No. 2, Supplement, S1 (1971)]. Data are evaluated, listed, averaged, and summarized in tables. (auth)

29181 HIGH-ENERGY MULTIPARTICLE REACTIONS. Frazer, W. R.; Ingber, L.; Mehta, C. H. (and others) (Univ. of California, San Diego, La Jolla). Rev. Mod. Phys.; 44: No. 2, 284-320(Apr 1972).

Hadronic multiparticle reactions at very high energies are reviewed with emphasis on current theoretical pictures and models. (auth)

29182 HIGH ENERGY PHYSICS INDEX. VOLUME 10, NO 7, 1972. Frankfurt am Main; Zentralstelle fuer Atomkern-energie-Dokumentation (1972). 67p.

29183 HIGH ENERGY PHYSICS INDEX. VOLUME 10, NO. 6, 1972. Frankfurt am Main; Zentralstelle fuer Atomkern-energie-Dokumentation (1972). 89p.

29184 ARE REGGE CUTS STILL WORTHWHILE? Schrempp-Otto, B.; Schrempp, F. (Univ., Hamburg). Springer Tracts Mod. Phys.; 61: 68-108(1972).

In this review first the considerable internal flexibility of Regge-cut models is emphasized. In order to reduce the flexibility, popular Regge-cut models (especially Argonne, Michigan) are confronted with a set of theoretical and decisive experimental constraints, the most important ones being the dual absorptive picture of Harari for the dip systematics and the new polarization data of πN-charge exchange. In general it is concluded that all current Regge-cut models are seriously affected by the set of constraints —even in the case of the "unproblematic" class of hadronic reactions, dominated by vector and tensor exchange. In particular the following results were found: the real parts of the helicity-nonflip amplitudes are wrong, i.e., by far too much absorbed, in the Michigan as well as in the Argonne model; moreover in the Michigan model the real parts of the helicity-flip amplitudes are wrong, too, there is much support for wrong signature nonsense zeros in the Regge-pole input and the correct crossover of elastic differential cross sections does not necessarily imply very strong absorption. Altogether a weak cut type model—if any—seems to be favored for the imaginary parts of the amplitudes. The real parts should then be calculated from fixed t-dispersion relations. (auth)

29185 HOW IMPORTANT ARE REGGE CUTS? Collins, P. D. B. (Univ. of Durham, Eng.). Springer Tracts Mod. Phys.; 60: 204-33(1971).

A review is given of recent progress in trying to justify the eikonal prescription for generating Regge cuts, and the different types of cut models which have been proposed are outlined. The various features of two-body reactions which cannot readily be explained by the Regge pole model are surveyed, and for each problem an attempt is made to decide how far the different cut models can offer a solution. It is concluded that there is very little need for cuts at all in helicity-flip amplitudes; indeed even weak cuts seem to make matters worse. On the other hand for nonflip amplitudes very strong cuts are needed, even stronger than those of the Michigan model in some cases. It is found that none of the presently available models is really favored by the experimental data. (auth)

29186 HIGH ENERGY INCLUSIVE PROCESSES. Tan, Chung-I (Brown Univ., Providence). Springer Tracts Mod. Phys.; 60: 91-106(1971). (NYO-2262-TA-246).

A brief survey is given of recent developments in the study of inclusive processes. The Mueller analysis is used in an attempt to separate the kinematic and dynamical aspects. The nature of the Mueller Regge hypothesis is illustrated in the dual resonance and multiperipheral models. (J.F.P.)

Electromagnetic

Refer also to abstracts 28907, 29323, 29348, 29356, 29362, and 29389.

29187 (COO-264-599) LEPTONIC AND HADRONIC SYMMETRIES. Freund, Peter G. O. (Chicago Univ., Ill.). Jan 1972. Contract AT(11-1)-264. 17p. (EFI-72-3). Dep. NTIS.

Two models for a gauge theory of the weak and electromagnetic interactions of leptons and hadrons are considered. The first model is based on the group $[SU(3)]^4$ = SU(3) × SU(3) × SU(3) × SU(3), the fundamental representation of which is spanned by left and right-handed lepton and quark triplets. The lepton triplet in-

volves the ν_e and $\bar{\nu}_\mu$ combined to a 4 component field, the e^- and the μ^+. A spontaneous symmetry breakdown is caused by the appearance of tadpoles. It is proved that the tadpoles responsible for the lepton and quark masses, by themselves, do not break the symmetry in a manner compatible with the observed universality properties of weak interactions. Many additional scalar fields are needed, and they are classified into specific $[SU(3)]^4$ multiplets. The model can account for the suppression of $|\Delta S| = 1$ neutral current induced semileptonic decays ($K \to \pi\nu\bar{\nu}$, $K^0 \to \mu^+\mu^-$, etc...). A quartet model based on the symmetry $U(4) \times U(4)$ is discussed. The model is simpler, but has to confront the absence of "charmed" hadrons in the low ($m \lesssim 2$-3 GeV) mass region. (auth)

29188 (COO-3065-1) DISPERSION INEQUALITIES AND THEIR APPLICATION TO THE PION'S ELECTROMAGNETIC RADIUS AND THE K_{l3} PARAMETERS. Okubo, S. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). 5 Jan 1972. Contract AT(11-1)-3065. 27p. (UR-369; CONF-720114-1). Dep. NTIS.

From Conference on fundamental interactions at high energy; Coral Gables, Fl. (26 Jan 1972).

Two kinds of dispersion inequalities are derived for f(t), a real analytic function of t. The values of f(t) and its derivatives below threshold are bounded above and below by integrals of $|f(t)|$ on the cut. These inequalities were applied to a variety of problems; in particular, it was possible to derive useful bounds on the electromagnetic radius of the pion, and on the scalar form factor of the K_{l3} decay matrix element as well as on $\pi^0 - \pi^0$ scattering lengths, and many other problems. (auth)

29189 (COO-3065-5) MODEL INDEPENDENT DEEP INELASTIC ELECTROPRODUCTION SUM RULES. Palmer, David R. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). 7 Feb 1972. Contract AT(11-1)-3065. 20p. (UR-373). Dep. NTIS.

Using the most general form for the null-plane commutator of the electromagnetic current, sum rules are derived for electroproduction in the deep inelastic region. The structure of these sum rules is discussed, and a free, massless, fermion model is considered as an illustration. (auth)

29190 (DESY-71/69) HIGH-ENERGY DELBRUECK SCATTERING FROM NUCLEI. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge. Dept. of Mathematics); Wu, Tai Tsun (Harvard Univ., Cambridge, Mass. Gordon McKay Lab. Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct 1971. Contract AT(30-1)-4101. 29p. Dep. NTIS.

The elastic scattering of a high-energy photon from a heavy nucleus, considered to be a static Coulomb field due to the charge Ze is studied. Exchange of an arbitrarily large number of photons with the nucleus is taken into account, and the effect of this multiphoton exchange is found to be very large, particularly for momentum transfers which are large compared with the rest mass of the electron. In addition, an interesting theoretical problem in this connection is formulated but unfortunately not solved. (auth)

29191 (DESY-71/70) ANOMALOUS MAGNETIC MOMENT OF THE CHARGED INTERMEDIATE VECTOR BOSON. Cheng, Hung; Wu, Tai Tsun (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct 1971. Contract AT(30-1)-4101. 54p. Dep. NTIS.

Assuming that the intermediate vector boson for weak interactions has no strong interactions, the Corben-Schwinger problem of the scattering of a charged vector meson with anomalous magnetic moment by an external static Yukawa potential, or in particular a static Coulomb field, is reinvestigated. Meixners' corner condition of finite integrated energy in every bounded region is applied in the neighborhood of the singularity of the Yukawa potential, and it is found that the Corben-Schwinger problem, although nonrenormalizable, possesses a finite, unique solution if and only if the anomalous magnetic moment is larger than 1. It is therefore a characteristic of nonrenormalizable theories that there may be lower bounds to coupling constants. Experimental determination of the anomalous magnetic moment of the intermediate vector boson is thus of great importance. Furthermore, because certain differential equations happen to be solvable in terms of Bessel functions, explicit perturbation expansion for weak coupling can be given for this scattering process. (auth)

29192 (DESY-71/71) COULOMB SCATTERING OF A CHARGED VECTOR MESON WITH ELECTRIC DIPOLE MOMENT. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge. Dept. of Mathematics); Wu, Tai Tsun (Harvard Univ., Cambridge, Mass. Gordon McKay Lab. Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct 1971. Contract AT(30-1)-4101. 16p. Dep. NTIS.

By including an electric dipole moment that leads to parity nonconservation, the previous investigation of the scattering of a charged vector meson by a static Yukawa potential, or in particular a static Coulomb field is generalized. The existence of a solution that satisfies Meixner's corner condition requires the following inequality between the anomalous magnetic moment κ and the electric dipole moment w: $\kappa > 1 + w^2$. In the special case where the electric dipole moment is absent, this condition reduces to the one obtained previously. (auth)

29193 (DESY-72/4) VECTOR MESON DOMINANCE AND SMOOTHNESS OF INVARIANT AMPLITUDES IN $\pi\Delta(1236)$ ELECTROPRODUCTION. Bartl, A.; Majerotto, W.; Schildknecht, D. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Feb 1972. 33p. Dep. NTIS (U. S. Sales Only).

The longitudinal and transverse parts of the $\pi\Delta(1236)$ electroproduction cross section are predicted from real photoproduction within the framework of vector-meson dominance, using the assumption of approximate mass independence of the invariant amplitudes for $VN \to \pi\Delta(1236)$. (auth)

29194 (JINR-E2-6257) FORWARD PHOTON-PHOTON SCATTERING AND THE ALGEBRA OF BILOCAL OPERATORS. Kunszt, Z.; Ter-Antonyan, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). Mar 1972. 30p. Dep. NTIS (U. S. Sales Only).

Different asymptotic regions for the process $\gamma^* + \gamma^* \to$ hadrons are considered from the point of view of the light-cone singularities. The contributions of the spin-0 and -½ bare constituents are calculated. Prospects of experimental tests of the algebra of bilocal operators are investigated. (auth)

29195 (JINR-E2-6283) MODEL OF PION AND KAON PHOTOPRODUCTION SUGGESTED BY QUANTUM MESODYNAMICS. Budnev, V. M.; Efremov, A. V.; Ginzburg, I. F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). Mar 1972. 8p. Dep. NTIS (U. S. Sales Only).

A new model for the charged π^- and K-photoproduction is proposed which describes near forward differential cross section of both reactions on an equal footing. This model includes the elementary pion with Toller number M = 0 and the pair of conspiring trajectories with M = 1. It is a result of summation of asymptotics of the Feynman diagrams in the γ^5-theory. (auth)

29196 NUCLEON ELECTROMAGNETIC MASS DIFFERENCE AND INELASTIC ELECTRON SCATTERING. Morishita, Norikazu. Mem. Chubu Inst. Technol.; 7: No. 12, 137-41(Dec 1971).

The p-n mass difference is considered from the point of view of a dispersion theory. The inelastic and Regge contributions are evaluated by using the $T_1(q^2, \nu)$ dispersion relation subtracted at $\nu = 0$, predictions of the vector-meson dominance model for inelastic electron-nucleon scattering, and total photoproduction cross sections of the proton and neutron given by simple Regge pole fits to the experimental data. It is found that $\delta M^{inel}(p-n) + \delta M^{Regge}(p-n) \simeq 0.4$ MeV. (1 table) (auth)

29197 FORMULA FOR THE BARYON MASS SPECTRA. Rosen, Gerald (Drexel Univ., Philadelphia). Phys. Rev., D; 5: No. 5, 1100-4(1 Mar 1972).

It is observed that the central and isospin-multiplet masses in the baryon octets and decuplets are given by the formula $M = M_P(1 + L + \frac{3}{8}S)^{\frac{1}{4}}f$, where $M_+ = 1014$ MeV for positive-parity states, $M_- = 1135$ MeV for negative-parity states, L and S denote the total orbital and total spin angular momentum of the spin-½ baryon constituents, and f is the hypercharge-isospin-splitting function. A simple modification of the semitheoretical formula yields the mass values observed for the unitary-singlet Λ's. The only experimentally established baryonic isospin multiplet with a mass not given by the formula (to within present experimental accuracy and the likely magnitude of electromagnetic shifts and splittings) is the N(1470) Roper resonance, believed to be a radial excitation of the nucleon with a mass that depends on a radial quantum number. (auth)

29198 EXOTIC CURRENTS IN PION PHOTOPRODUCTION. Donnachie, A. (Univ. of Manchester, Eng. Daresbury Nuclear Physics Lab., Eng.); Shaw, Graham. Phys. Rev., D; 5: No. 5, 1117-38(1 Mar 1972).

A detailed analysis is made of the pion photoproduction and pion radiative-capture data in the first resonance region in terms of a simple model incorporating C-violating and isotensor effects. An excellent fit is obtained, and the data can only be understood in the presence of the exotic terms. The stability of the parameters representing these effects is investigated against detailed variations in the model and against possible ambiguities in the proton data. The parameters specifying the ratio of isotensor to isovector resonance excitation (t) and the T-violating phase on neutrons (ϕ_n) are found to be stable, and have the values $t \sim -0.28$ and $\phi_n \sim -11°$. The consequences of this on other processes are briefly summarized and found to be compatible with the present information. A discussion of the model-independent aspects of these ques-

tions is also given, including a critical review of other work known to the authors. Conventional models, i.e., those without exotic terms, are demonstrated to be incapable of describing the present data without violating more fundamental requirements. The particular exotic terms needed depend to some extent on the model; however, this dependence can be eliminated by improved data. (auth)

29199 ELASTIC AND INELASTIC FORM FACTORS OF THE NUCLEONS AND DEEP-INELASTIC ELECTROPRODUCTION. Moreno, Hector; Pestieau, Jean (Instituto Politecnico Nacional, Mexico City). Phys. Rev., D; 5: No. 5, 1210-16(1 Mar 1972).

It is proposed that, in the scaling limit, the structure functions of inelastic electroproduction on nucleons are sums of resonances. Their analytical forms are derived from the parton model and from the phenomenological result that "scaling" occurs faster in terms of the variable $\omega' = \omega + M^2/Q^2$ than in terms of ω. The analytical expressions of the electromagnetic form factors are related to those of the structure functions. (auth)

29200 $e^+e^- \rightarrow n\pi^+n\pi^-$ VIA TWO PHOTONS. Buchl, R. A.; Nigam, B. P. (Arizona State Univ., Tempe). Phys. Rev., D; 5: No. 5, 1150-2(1 Mar 1972).

Using the result derived by Terazawa for the reduction of n pion pairs from the matrix element, the total cross section was calculated for the process $e^+e^- \rightarrow n\pi^+n\pi^-$ via two virtual photons. The validity of Weinberg's first sum rule was assumed. Using an approximate expression due to Bjorken and Brodsky the multipion phase-space integral was performed. (auth)

29201 ELECTROPRODUCTION AND THE SIZE OF A VIRTUAL PHOTON. Kogut, J. B. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., D; 5: No. 5, 1152-60(1 Mar 1972).

The possibility that the radius of interaction between a virtual photon and a proton varies sensitively as the mass of the photon changes. This phenomenon is studied in quantum electrodynamics and in multiperipheral and constituent models. Physical arguments are also presented which claim that the radius of interaction should vary significantly as Q^2 changes from 0 to 1 GeV^2. If experiments confirm these expectations, then new and dramatic experimental tests of the presence of multiperipheral mechanisms in photon-initiated processes can be made. (auth)

29202 OBSERVATIONS ON THE ISOSTRUCTURE OF CURRENTS. Pais, A. (Rockefeller Univ., New York). Contract AT(11-1)-3505. Phys. Rev., D; 5: No. 5, 1170-9(1 Mar 1972).

Model-independent implications of the isostructure of currents for γ-, e-, ν-, and $\bar{\nu}$-induced production reactions are noted. Reactions on hydrogen and deuterium only are considered; separate neutron information is not used. Numerous tests are given for the absence of I = 2 (or specific higher I values), for the electromagnetic current, and for the weak $\Delta S = 0$ current (independent of class). Similar results are derived for the $|\Delta I| = \frac{1}{2}$ rule for $|\Delta S| = 1$ currents, where $\bar{\nu}$-d reactions are most favorable. A consequence for K_{μ} decays is mentioned. The expansion of cross sections in terms of the azimuthal angle between the lepton and a hadron plane yields equalities implied by the absence of second-class currents (independent of isospin content) in T-conserving situations. Here the ν and $\bar{\nu}$ disintegrations of the deuteron are of special interest. (auth)

29203 RETURN TO FIELD MECHANICS. Bopp, Fritz (Ludwig-Maximilians Univ., Munich). Atomkernenergie; 19: No. 2, 77-84(Apr 1972). (In German).

The motion of charged mass points in their own electromagnetic field may be described as a purely many body problem (Fokker 1929). It is proven that the field and particle point of view are mathematical equivalents in classical physics. Both versions of the theory may be therefore possible starting points for quantization. That of the so-called field mechanics is not yet considered very deeply. This should be done a little bit more. One obtains in a certain approximation a mass spectrum with finite masses even in the limit of a pure Coulomb field if one introduces a proper scaling. But unfortunately the spectrum is not yet realistic. Further investigations must show, how far that is a consequence of the approximation or of the fact that half-odd spins and polarization effects are not yet taken into account. Having creating processes in mind, one does not overestimate the field mechanical method. Yet, it might give a hint that pure quantum electrodynamics will provide one with solutions for particles with different masses, and that one will find them if one succeeds in computing mass ratios rather than mass differences. (auth)

29204 COMPTON SCATTERING AND INDUCED COMPTON SCATTERING IN A CONSTANT ELECTROMAGNETIC FIELD. Herrmann, J. (Univ., Jena, Ger.); Zhukovskii, V. Ch. Ann. Phys. (Leipzig); 27: No. 4, 349-58(1971).

The spectral and angular distributions for the Compton effect in a constant electromagnetic field are obtained. The possibility of the existence of the induced Compton scattering in an external field (i.e. two-photon emission, one of the two photons being induced by the incident wave) is demonstrated. In the case of a constant magnetic field the deviation from the Klein–Nishina formula of the obtained distribution for the Compton effect as well as the behavior of the distribution for the induced Compton effect are discussed. The optimal region of the parameters for the possible experimental test of these effects is given. (auth)

29205 MOMENTUM OF PHOTONS IN A TRANSPARENT MEDIUM AND THE MACROSCOPIC RECOIL OF THE INTERFACE. Costa de Beauregard, Olivier (Institut Henri Poincare, Paris). Compt. Rend., Ser. B; 274: No. 3, 164-6(17 Jan 1972). (In French).

Using general mechanics theorems (center-of-mass theorem, momentum theorem), it is shown that the recoil of an interface of index n leads to the macroscopic occurrence of a momentum proportional to the group velocity, which, in the absence of dispersion ($dn/d\nu = 0$) has the simple value of $h\nu/nc < h\nu/c$. (France)

29206 SOFT PION THEOREMS AND DISCONTINUITY FORMULAS IN INCLUSIVE REACTIONS. Sakai, N. (Tokyo Univ.). Nucl. Phys.; B39: No. 1, 119-32(1972).

It is pointed out that the soft pion limit of inclusive cross sections cannot be obtained in terms of discontinuities of the soft pion limit of the corresponding six-point functions. It is proved that the correct result can be obtained only if the discontinuity is extracted before the limit is taken. Some practical applications are described in separate papers. (auth)

29207 EFFECTIVE LAGRANGIAN MODEL FOR DOUBLE-PION PHOTOPRODUCTION. Pittner, L.; Urban, P. (Univ., Graz). Nucl. Phys.; B39: No. 1, 227-36(1972).

A relativistic covariant and gauge invariant scattering amplitude for double-pion photoproduction is constructed by using an effective Lagrangian model. Total and differential cross sections for the scattering process $p\gamma \rightarrow p\pi^+\pi^-$ are evaluated and compared with the results of other theoretical models and with experimental data. (auth)

29208 EFFECT OF ISOVECTOR NATURAL-PARITY EXCHANGE IN VECTOR MESON PHOTOPRODUCTION. Fuchs, Norman H. (Purdue Univ., Lafayette, Ind.). Nucl. Phys.; B39: No. 1, 587-95(1972).

The effect of an isovector natural parity (A_2) exchange amplitude in ρ^0 and ω photoproduction at high energy from hydrogen, deuterium, and complex nuclei is investigated. The predictions of two phenomenological models are compared with experiment and are found to be in fair agreement, although more accurate data could distinguish the models. Photoproduction of ω from complex nuclei may be affected strongly by the existence of A_2 exchange contributions of the magnitude suggested by the vector dominance model. (auth)

29209 ANALYSIS OF PHOTO AND ELECTROPRODUCTION DATA AGAINST ω_W. Brasse, F. W. (DESY, Hamburg); Chazelas, E.; Fehrenbach, W.; (and others). Nucl. Phys.; B39: No. 1, 421-31(1972).

A detailed analysis is made of scaling and local duality of the two structure functions W_1 and νW_2 characterizing inelastic electron scattering, against the variable $\omega_W = (2M\nu + M_W^2)/(q^2 + a^2)$. For this purpose a compilation of world data spanning the resonance and deep inelastic region and including photoproduction was used. It is shown that to the accuracy allowed by present experiments, ω_W is a good variable for all ν and q^2 values, including real photons. (auth)

29210 PHASE OF $\gamma p \rightarrow \pi^0 p$ IN THE FORWARD DIRECTION. Carreras, B. (Daresbury Nuclear Physics Lab., Eng.); Sanchez-Gomez, J. L. Nucl. Phys.; B40: 199-204(1972).

A calculation of the phase of the forward amplitude for $\gamma p \rightarrow \pi^0 p$ is presented. It was done by means of the so called modulus dispersion relations. The pion photoproduction amplitudes for isospin $I = \frac{1}{2}$ and $I = \frac{3}{2}$ are also given. (auth)

29211 MEASURABILITY OF THE SPIN AND MAGNETIC MOMENT OF THE FREE ELECTRON. Kalckar, J. (Univ. of Copenhagen). Nuovo Cim.; 8A: No. 4, 759-77(21 Apr 1972).

The old problem, discussed in particular by Bohr and Pauli, concerning the measurability of the intrinsic spin and magnetic moment of a free electron, is reconsidered. The sense in which the spin can or cannot be regarded as measurable is discussed. It is emphasized that the well-known impossibility, by means of a Stern–Gerlach experiment or related magnetometer arrangements, to define the magnetic moment of a free electron does not in itself imply any restriction on the measurability of the electron spin. The failure of the measuring arrangements referred to is, in fact,

independent of the value of the spin of the atomic particle, as long as a local coupling between the charge-current density and the electromagnetic field is assumed. The crucial feature turns out to be the very incompatibility of the idealization of a point charge, on the one hand, and the classically defined notion of a magnetic moment, on the other hand. (auth)

29212 $K^+ - K^0$ AND $\pi^+ - \pi^0$ MASS DIFFERENCES IN BROKEN CHIRAL SYMMETRY. Dutt, R.; Eliezer, S. (Technion-Israel Inst. of Tech., Haifa). Nuovo Cim.; 8A: No. 4, 741-7(21 Apr 1972).

If the nonelectromagnetic isospin symmetry-breaking term is included in the broken chiral $SU_3 \otimes SU_3$ model, the correct sign and right order of magnitude of the K^+-K^0 mass shift are reproduced by using spectral-function sum rules with the assumptions of meson dominance and asymptotic symmetry. The numerical estimates of the symmetry-breaking parameters, the $\pi^+-\pi^0$ mass difference, and a number of coupling constant ratios are consistent with other predictions. (auth)

29213 THEORETICAL INVESTIGATION OF THE REACTION $\gamma\gamma \rightarrow \pi\pi$ AND THE $\epsilon \rightarrow \gamma\gamma$ AND $f \rightarrow \gamma\gamma$ DECAY WIDTHS. Schierholz, G.; Sundermeyer, K. (Univ., Hamburg). Nucl. Phys.; B40: 125-40(1972).

The $\gamma\gamma \rightarrow \pi\pi$ cross section and the $\epsilon \rightarrow \gamma\gamma$ and $f \rightarrow \gamma\gamma$ decay widths are calculated on the basis of partial-wave dispersion relations. The left hand cut integral is approximated by vector meson exchange diagrams. On the right hand cut elastic unitarity is taken into account which establishes a close correspondence between the cross section and the $\pi\pi$ phase shifts. The I = 0, J = 2 phase shift is parametrized in terms of the f(1260) and for the corresponding J = 0 phase shift a "down" and an "up" solution (ϵ Breit-Wigner) is considered. The cross section is found to depend sensitively on the form of the $\pi\pi$ final state interaction. The obtained $\epsilon \rightarrow \gamma\gamma$ and $f \rightarrow \gamma\gamma$ couplings are compared with other estimates. (auth)

29214 LIGHT-CONE EXPANSIONS AND FORM FACTORS. Chanda, R.; Ryan, C. (University Coll., Dublin). Nucl. Phys.; B40: 573-95(1972).

On the assumption that the asymptotic behavior of form factors arises from the corresponding configuration space matrix element in the neighborhood of the light cone, the concept of operator product expansions near the light cone is used to determine the nature of this behavior. It is found that as $|q^2| \rightarrow \infty$ all form factors go either as a constant or as some power of q^2 where the power is related to the scale dimension of the operators involved. Form factors connected with the matrix elements of scalar and vector operators are considered and applications to K_{l3}, PCAC, mass and electromagnetic form factors are explicitly discussed. (auth)

29215 SCALING IN EXCLUSIVE ELECTROPRODUCTION AND COMPOSITE HADRONS. Weis, J. H. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Phys.; B40: 562-72(1972).

It is noted that for composite hadrons the usual high-energy behavior of amplitudes and large q^2 behavior of form factors suggest that the amplitude for electroproduction of a single particle behaves in the Bjorken limit as $M \sim F_0(q^2)g(\omega,t)$ for large ω. The form factor $F_0(q^2)$ gives the electromagnetic coupling of the produced hadron to the lowest resonance on the leading t-channel trajectory. It is suggested that this behavior may hold for all ω, as is the case in several models. Some implications of this behavior for the resonance saturation of M are discussed. The general discussion is illustrated by the study of a simple dual resonance model. (auth)

29216 MASS AND WIDTH OF THE $\Xi(1530)$. Kirsch, L. (Brandeis Univ., Waltham, Mass.); Schmidt, P.; Chang, C. Y.; (and others). Nucl. Phys.; B40: 349-66(1972).

286 $\Xi^0(1530)$ and 185 $\Xi^-(1530)$ events corresponding to production cross sections of 29 μb and 26 μb respectively are analyzed for mass, width and electromagnetic mass difference. The distribution of invariant mass errors and important systematic effects are included in the analysis. A width of 11.0 ± 1.8 MeV for the $\Xi^0(1530)$ and of 16.2 ± 4.6 for $\Xi^-(1530)$ are obtained. The former is in some disagreement with the presently accepted value of 7.3 ± 1.7 MeV while the latter is the only such reported measurement to date, and these new values bring the world average value into closer agreement with the prediction of unbroken SU(3). Corresponding masses are 1532.3 ± 0.7 MeV and 1536.2 ± 1.6 MeV giving a mass difference of $\Delta M = 3.9 \pm 1.8$ MeV and lead to a world average value of ΔM of 4.3 ± 1.3 MeV. Some conclusions regarding measurement of resonant widths are made. (auth)

29217 $\eta \rightarrow 3\pi$ AND ELECTROMAGNETIC TADPOLES. Loodts, J. A. C.; Mannheim, P. D.; Brout, R. (Univ. Libre, Brussels). Nucl. Phys.; B40: 375-85(1972).

The difficulties presented by current algebra in treating the $\eta \rightarrow 3\pi$ decay, and Wilson's resolution in terms of short distance behavior of operator products of local currents are discussed. The non-applicability of PCAC for neutral pions in $\eta \rightarrow 3\pi$ is related to the logarithmic divergence of the Cottingham formula for $\Delta I = 1$ electromagnetic mass differences coming from the scaling region. Introduction of a u_3 tadpole which acts as a renormalization counter-term then provides a systematics for electromagnetic mass differences and also for calculating the $\eta \rightarrow 3\pi$ decay. The Lovelace-Veneziano pole model precisely realizes this systematics. The ensuing agreement with the structure of the Dalitz plot and total rate for the decay is found to be excellent. Also the use here of the Veneziano formula is compared with its use in $\bar{p}n \rightarrow 3\pi$. (auth)

29218 GLAUBER AND SYMMETRIZATION CORRECTIONS TO π^- PHOTOPRODUCTION DATA FROM SINGLE ARM SPECTROMETER EXPERIMENTS. Julius, D. I. (Univ., Karlsruhe, Ger.). Nucl. Phys.; B40: 409-16(1972).

Using previously derived expressions for two-step processes in pion photoproduction from deuterium and a detailed fit to the high energy data, a careful evaluation of the corrections to small momentum transfer π^- data obtained from deuterium target experiments was made. For the energy range 2 to 16 GeV and photons polarized perpendicular to the production plane, it is found that corrections to the usual prescription for obtaining the π^- production cross section from the neutron do not exceed 4%. For photons polarized parallel to the reaction plane, an upper limit of 1% is found for the same energy range. The results indicate that the corrections could become considerably larger at somewhat lower energies where the formation of several isospin $\frac{1}{2}$ direct channel resonances plays an important role in the production process. (auth)

29219 K^+ PHOTOPRODUCTION LOW-ENERGY DESCRIPTION AND DUALITY RELATIONS. Renard, Y. (Departement de Physique Mathematique, Montpellier, France). Nucl. Phys.; B40: 499-540(1972).

An analysis of the reactions $\gamma + p \rightarrow K^+ + \Lambda$ and $\gamma + p \rightarrow K^+ + \Sigma^0$ is performed for photon energies from threshold up to 1850 MeV. An isobaric model including Born terms and s- and u-channel resonances is used with the help of relativistic invariant and gauge invariant couplings and propagators. The fits to the experimental data are optimized by minimizing the usual χ^2, the parameters being the coupling constants. In both cases the values $-10 \lesssim g_{\Lambda KN} \lesssim -4$ and $1.3 \lesssim g_{\Sigma KN} \lesssim 2$ are favored. A comparison between the low-energy and high-energy regions is made on the imaginary part of the four helicity amplitudes and on the effective trajectories in the sense of the FESR averaging; the high-energy amplitude is taken from the model proposed by Capella and Tran and based on a K^*-K^{**} exchange degeneracy and the presence of a weak K^*-pomeron cut. In the case of $\gamma + p \rightarrow K^+ + \Lambda$ it is shown that our low-energy amplitude reproduces well on the average the features of the high-energy amplitude. (auth)

29220 DEVIATIONS FROM THE SCALING LAW FOR PROTON FORM FACTORS. Papini, G (Univ. of Saskatchewan, Regina). Lett. Nuovo Cim.; 3: No. 16, 657-60(15 Apr 1972).

It is shown that the scaling law previously derived for proton form factors (Lett. Nuovo. Cimento: 2: 1370(1971)) holds true only for small values of the momentum transfers. The deviations from the scaling law for increasing four-momentum transfer are calculated. (L.B.S.)

29221 SUM RULE FOR THE CHARGE RENORMALIZATION CONSTANT IN QUANTUM ELECTRODYNAMICS. Pradhan, T. (Saha Inst. of Nuclear Physics, Calcutta). Lett. Nuovo Cim.; 3: No. 16, 669-72(15 Apr 1972).

It is shown that the question of finiteness of the charge renormalization constant in spinor quantum electrodynamics can be decided from experimental data on total cross sections for high-energy photon-electron collisions. It is shown that the components of electric current and spin operators in quantum electrodynamics form a closed compact algebra from which a sum rule for the charge renormalization constant can be derived. (L.B.S.)

29222 TACHYONS AND CHERENKOV RADIATION. Wimmel, H. K. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Nature (London) Phys. Sci.; 236: No. 66, 79-80(3 Apr 1972).

The theory of Cherenkov radiation from tachyons is discussed, and the results of Lapedes and Jacobs (Nature Phys. Sci., 235: 6(1972)) and Alvager and Kreisler (Phys. Rev., 171: 1357(1968)) and others are shown to be invalid. The classical particle model and various field models of tachyons are discussed in the present context. (UK)

29223 LIGHT-CONE SINGULARITIES AND LORENTZ POLES. Ferrara, S. (CNEN, Frascati, Italy); Rossi, G. J. Math. Phys. (N. Y.); 13: No. 4, 499-504(Apr 1972).

The causal Meyer-Suura structure functions are projected into irreducible representations of the Lorentz group. A clarification of the connection between light-cone singularities and Lorentz

poles is obtained. It is found that in general a light-cone singularity of the type $1/(-\chi^2 + i\epsilon\chi_0)^\alpha$, in the operator product of the hadronic electromagnetic current, is built up from a sequence of Lorentz poles at $\lambda_n = 1 + \alpha - n$ whose residues are polynomials of order n in the virtual photon square mass. (auth)

Weak

Refer also to abstract 29143.

29224 (COO-264-598) SELF-COUPLING OF WEAK LEPTON CURRENTS IN HIGH-ENERGY NEUTRINO AND MUON REACTIONS. Fujikawa, Kazuo (Chicago Univ., Ill. Enrico Fermi Inst.). Jan 1972. Contract AT(11-1)-264. 30p. (EFI-72-2). Dep. NTIS.

The transverse momentum distribution of the muons in the reaction $\nu + (z) \rightarrow \nu + \mu + \bar{\mu} + (z)$ is discussed. The lower end of the energy spectrum of the muons in the previous study is also modified by using an improved interpolation formula. (auth)

29225 ANOMALY-FREE VERSION OF WEINBERG'S MODEL. Bouchiat, C.; Iliopoulos, J.; Meyer, Ph. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Lett.; 38B: No. 7, 519-23(3 Apr 1972).

The difficulties of carrying out the renormalization program in a theory containing Adler anomalies are discussed. Some models of weak and electromagnetic interactions, involving both lepton and quark fields, in which the troublesome anomalies cancel are presented. (auth)

29226 THRESHOLD RELATIONS FOR INELASTIC NEUTRINO-NUCLEON INTERACTIONS. Cleymans, Jean; Rodenberg, Rudolf (Physikalisches Institut, Aachen). Phys. Rev., D; 5: No. 5, 1205-10(1 Mar 1972).

Threshold relations, following from scaling and duality, are obtained for inelastic neutrino-nucleon interactions. Reasonable agreement with existing experimental data is found. It is noticeable that some of the relations are in disagreement with predictions from the parton model. (auth)

29227 SHORT-DISTANCE SCALE INVARIANCE AND THE STRUCTURE OF WEAK TRANSITIONS. Roy, Probir (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 5: No. 5, 1180-91(1 Mar 1972).

The effects of short-distance interactions between hadronic weak currents on the structure of weak transitions are investigated within Wilson's scheme of operator-product expansions and broken scale invariance. It is pointed out that a consistent understanding of these effects can be attained with the hypothesis that the dimensions of nonexotic fields are near-canonical while those of exotic fields are anomalously high. The lack of structure-dependent effects in the $\Delta I = 1/2$ part of ordinary nonleptonic decay, the suppression of the $\Delta I = 3/2$ part in the same, and the smallness of the K_1^0-K_2^0 mass difference are first explained following Wilson's arguments. The structure of higher-order semileptonic decays disobeying the $\Delta S = \Delta Q$ role is then discussed. Finally, the important role played by short-distance effects in radiative nonleptonic decays of hadrons is elucidated and a mechanism for the large asymmetry parameter observed in the reaction $\Sigma^+ \rightarrow p + \gamma$ is obtained. (auth)

29228 SYMMETRY OF LEPTONIC WEAK INTERACTIONS AND LEPTON MASS SPECTRUM. Hsu, J. P. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev., D; 5: No. 5, 1161-3(1 Mar 1972).

The invariance principle that excludes the neutral leptonic currents and uniquely determines the leptonic weak interactions is discussed. Based on symmetry considerations and the existence of two different neutrinos, it is suggested that the neutrino masses are not strictly zero and there are new heavy charged leptons and their neutrinos. A possible lepton mass spectrum is obtained. (auth)

29229 BOUNDS ON K_{l3} PARAMETERS. II. Tanaka, K. (Royal Inst. of Tech., Stockholm. Ohio State Univ., Columbus); Torgerson, R. Phys. Rev., D; 5: No. 5, 1164-9(1 Mar 1972). Contract AT(11-1)-1545.

Bounds on the coefficients of the quadratic terms in the scalar and vector form factors for K_{l3} decay are sharpened in the framework of chiral SU(3) ⊗ SU(3) breaking. The bound on the scalar form factor is found to be consistent with the prediction of the Callan-Treiman relation. (auth)

29230 DIFFERENTIAL CROSS SECTION OF ELECTRON-POSITRON PAIR ANNIHILATION IN TRANSNORMALIZED THEORY OF WEAK INTERACTION. Guliev, N. A.; Dzhafarov, I. G. (Inst. of Physics, Baku). Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk; No. 1, 52-9(1971). (In Russian).

The effect of the weak interaction in the Tanikawa-Watanabe-Shabalin model during annihilation of an electron and a positron was examined in the pairs: proton-antiproton, pion-antipion, and neutrino-antineutrino. The contribution of such an interaction to the cross section for available energies exceeds the contribution from an ordinary single-photon exchange. The formulas obtained for such cross sections have the general character and application in the case of (V-A)-structures of the interaction of neutral currents provided that the mass of the barolepton be considered infinitely large. The following processes were considered: $e^+ + e^- \rightarrow p + \bar{p}$, $e^+ + e^- \rightarrow \pi^+ + \pi^-$, and $e^+ + e^- \rightarrow \nu_\mu + \bar{\nu}_\mu$. (K.S.W.)

29231 W^+-MESON DECAY. Elkishen, M.; Zidan, M. (Cairo Univ.). Ann. Phys. (Leipzig); 27: No. 4, 365-9(1971).

Assuming that photons can interact weakly with neutrinos and vector mesons, the rate of $W^+ \rightarrow e^+ + \nu + \gamma$ decay is calculated. The anomalous magnetic moment and electric dipole moment of the W are included. (J.F.P.)

29232 HIGH-LUMINOSITY, HIGH-RESOLUTION STUDY OF THE END-POINT BEHAVIOR OF THE TRITIUM β-SPECTRUM. I. BASIC EXPERIMENTAL PROCEDURE AND ANALYSIS WITH REGARD TO NEUTRINO MASS AND NEUTRINO DEGENERACY. Bergkvist, Karl-Erik (Univ. of Stockholm). Nucl. Phys.; B39: No. 1, 317-70(1972).

An experimental investigation of the end-point region of the tritium β-spectrum is described. The data obtained are analyzed with regard to their implications with respect to neutrino mass and neutrino degeneracy. By employing combined electrostatic-magnetic β-spectroscopic methods, a gain of about three orders of magnitude has been achieved with regard to basic intensity conditions. By combining this with attention to the production of a high-quality source and to the control of the background, it has become possible to study the tritium spectrum considerably closer to the end-point than previously feasible. A number of precautions have been taken to ensure an analysis free from systematic errors. At a 90% confidence level, upper limits of 55-60 eV can be set on the electron-neutrino mass and on the Fermi-energy of a universal neutrino or antineutrino degeneracy. No evidence for actually finite values of these parameters is found. The new upper limits are 5-20 times smaller than given by previous direct evidence. The experimental energy resolution achieved in the investigation is such that inherent atomic effects in the measured β-spectrum will severely limit further improvement in actual, effective resolution. (auth)

29233 CP VIOLATING NEUTRAL LEPTONIC CURRENTS AND $K_{1,S}^0 \rightarrow \mu\bar{\mu}$ DECAYS. Okubo, S.; Bace, M. (Univ. of Rochester, N. Y.). Nucl. Phys.; B40: 541-61(1972).

On the basis of a CP violating model with strong self-interaction among the intermediate vector mesons, the existence of CP violating neutral leptonic currents is predicted. This model can explain the puzzling decay modes $K_{1,S}^0 \rightarrow \mu\bar{\mu}$. Various rare decay modes such as $K_1^0 \rightarrow \pi^0 ee$, $K_1^0 \rightarrow \pi^+\pi^0 e\bar{\nu}$ and $\pi^+\pi^- e\bar{e}$ as well as $K^+ \rightarrow \pi^+ e\bar{e}$ and $\pi^+\nu\bar{\nu}$ are discussed. (auth)

29234 PREDICTIONS FOR THE DECAYS $\Sigma^+ \rightarrow p\mu + \mu^-$ AND $\Sigma^+ \rightarrow pe^+e^-$. Corrigan, Dennis; Trofimenkoff, N. N. (Univ. of Calgary, Alberta). Nucl. Phys.; B40: 98-102(1972).

Partial and total decay rates for the processes $\Sigma^+ \rightarrow p\mu^+\mu^-$ and $\Sigma^+ \rightarrow pe^+e^-$ are calculated in terms of the $\Sigma^+ \rightarrow p\gamma$ decay amplitudes. It is shown that measurements of these decay rates can be used to determine the relative magnitudes of the parity-violating and parity-conserving $\Sigma^+ \rightarrow p\gamma$ decay amplitudes. The experimental value of the asymmetry parameter for the decay $\Sigma^+ \rightarrow p\gamma$ is used to predict the $\Sigma^+ \rightarrow p\mu^+\mu^-$ and $\Sigma^+ \rightarrow pe^+e^-$ total decay rates. (auth)

29235 NEUTRINO MASS BOUNDS. Cawley, R. G. (Naval Ordnance Lab., Silver Spring, Md.). Lett. Nuovo Cim.; 3: No. 12, 523-5(18 Mar 1972).

Attention is called to the omission of mass bounds for the neutrino obtained from the spacelike (tachyon) site. Improved estimates of the upper bounds of the muon neutrino corresponding to the particle and tachyon cases are presented. (L.B.S.)

29236 LIGHT-CONE COMMUTATORS AND ADLER'S SUM RULES. Ng, Wing-chiu (New York Univ., N. Y.). Lett. Nuovo Cim.; 3: No. 12, 503-6(18 Mar 1972).

Light-cone commutators are applied to the reformulation of two of Adler's fixed-mass sum rules for neutrino scattering. The sum rules are found to be radically modified. (L.B.S.)

29237 EXTENSION OF WEINBERG'S MODEL OF LEPTONS. Beckers, J. (Univ., Liege). Lett. Nuovo Cim.; 3: No. 12, 473-7(18 Mar 1972).

Weinberg's model for leptons is extended to the whole leptonic set, including electron-type and muon-type leptons. In particular, the two neutrinos, the electron, and the muon are incorporated in a

scheme which gives the leptonic charge through a phenomenological formula analogous to the Gell-Mann–Nashijima one. (L.B.S.)

29238 CURRENT ALGEBRA AND FINAL-STATE INTERACTIONS IN NON-LEPTONIC HYPERON DECAYS. Reid, J. H.; Trofimenkoff, N. N. (Univ. of Calgary, Alberta). Nucl. Phys.; B40: 255-68(1972).

The current-algebra-PCAC method as applied to nonleptonic hyperon decays is reformulated without assuming that the final-state interactions vary slowly as the pion momentum is taken to zero. This reformulation leads to integral equations of the Omnès type for the decay amplitudes. The integral equations are solved and the effects of the final-state interactions on the equal-time commutator and Born terms are evaluated. The main results are: (i) The final-state interactions do not vary slowly as the pion momentum is taken to zero. (ii) The final-state interactions bring the calculated amplitudes into good agreement with the experimental amplitudes except for the parity-violating amplitude of the decay $\Sigma^+ \rightarrow n\pi^+$. (auth)

29239 MECHANISM OF μ^- MESON DEPOLARIZATION IN MOLECULAR CONDENSED MEDIA. Dzhuraev, A. A.; Evseev, V. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz.; 62: No. 3, 1166-74(Mar 1972). (In Russian).

The effect of rapid chemical mesic atom reactions on depolarization of the negative muon is considered on basis of the concept of a "coulomb explosion" resulting from the high ionization of the molecule in Auger transitions in the mesic atom. It is shown that the experimental dependence of residual muon polarization on temperature in the case of atom capture by water corresponds to the mean time required for the mesic atom produced to participate in the chemical reaction, this being $(8.3 \pm 1.2) \cdot 10^{-12}$ sec at 80°K and $(2.5 \pm 0.4) \cdot 10^{-12}$ sec at 273°K. (auth)

29240 TESTS FOR HEAVY LEPTON PRODUCTION IN INCLUSIVE NEUTRINO REACTIONS. Albright, Carl H. (Northern Illinois Univ., DeKalb). Phys. Rev. Lett.; 28: No. 17, 1150-4(24 Apr 1972).

A phenomenological study is carried out for the production of μ-type leptons in one-particle inclusive neutrino reactions. The muon spectrum is found to be distorted in a significant fashion from that expected with no heavy-lepton production, and sensitive tests are presented which serve to signal the fleeting presence of such excited leptons. (auth)

Strong (General)

29241 (DESY-72/7) SELF-TRAPPING FIELD OF QUARKS IN HADRONS. Suura, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Feb 1972. 9p. Dep. NTIS.

A formulation is given for a physical situation in which a large self mass of quarks acts as a trapping barrier for bare quarks. A vector cohesive field in a hadron is considered in the classical limit and a proper field is assumed to be three dimensional. From 1/r expansion of the self-field of the quark an asymptotic hadron mass spectrum follows almost uniquely. In the limit of an infinitely heavy quark, the mass spectrum reduces to that of a single four-point Veneziano amplitude. (auth)

29242 CONSERVATION LAWS IN PARTICLE PRODUCTION IN NN AND $\bar{N}N$ INTERACTIONS AND THE STRUCTURE OF THE NUCLEON. Wang, Chia Ping (Case Western Reserve Univ., Cleveland). Particles Nucl.; 1: No. 3, 207-19(Dec 1970).

The characteristics of multiple production in NN, $\bar{N}N$ and other hadronic interactions are expressed in terms of conservation laws with the general reaction equation which relates directly to the substructure of the nucleon (and other hadrons). The average "charge multiplicity minus two" due to pp and π^+p collisions from threshold up to 10^4 GeV is found to follow the same logarithmic law of increase with energy, $\langle n_S - 2\rangle = C \cdot \ln (E_{cm}/E_\phi)$, or up to 3×10^3 GeV, the same power law, $\langle n_s - 2\rangle = a E_{cm}^b$, with $b \approx \frac{1}{2}$ at high energies ($\gtrsim$60 GeV). (auth)

29243 DUALITY AND WEAK ENERGY DEPENDENCE OF SINGLE-PARTICLE SPECTRA. Freeman, J. Reuben (State Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. Phys. Rev., D; 5: No. 5, 1231-4(1 Mar 1972).

For the inclusive process, a + b → c + anything, it is suggested that the invariant cross section for the fragmentation of b has weak energy dependence if $ab\bar{c}$ or $b\bar{c}$ is an exotic channel. This is shown to follow directly from the criterion of Chan et al. that weak energy dependence is present when just $ab\bar{c}$ is an exotic channel. The duality criterion for energy independence in the central region—$a\bar{c}$ and $b\bar{c}$ are exotic channels—is examined. Problems which arise from having a different duality criterion for fragmentation and central distributions are discussed. (auth)

29244 STRUCTURE CONSTANT OF RESONANCES. THE UNIVERSAL CONSTANT α COMMON TO ANY RESONANCES IN ANY REACTIONS. Hirano, Massanobu; Ito, Akihiro; Iwata, Kenzo; (and others) (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto); 46: No. 6, 1937-8(Dec 1971).

It is suggested that in the harmonic oscillator model the characteristic constant is strongly connected with the structure of resonances and that this constant may be common to all resonances in all reaction processes. (L.B.S.)

29245 TESTS OF SU(3) IN PARTICLE REACTIONS. Trilling, George H. (Univ. of California, Berkely). Nucl. Phys.; B40: 13-31(1972).

It is shown that SU(3) symmetry is well satisfied in hadron and photoproduction reactions provided that both phase-space and angular momentum barrier effects are introduced in the corrections made to take account of mass differences. Thus observed deviations from SU(3) symmetry are satisfactorily accounted for by the kinematic consequences of mass differences without the necessity of postulating additional dynamical corrections. Near the forward direction, these kinematic effects are substantial even at energies above 10 GeV. (auth)

29246 SPINOR SPACE APPROACH TO HADRON MASS FORMULA. Araki, S.; Okubo, S. (Hokkaido Univ., Sapporo). Lett. Nuovo Cim.; 3: No. 12, 511-14(18 Mar 1972).

An automatic mass-splitting mechanism was obtained by Smrz in a formalism for the fine structure of space time, where the external space-time point is a bilinear form of fundamental bispinors. The formalism is modified with the assumption that all of the three fundamental bispinors are transformed by SO(4,1) de Sitter transformation in different ways; this modification leads to the appropriate mass formula. The explicit mass formula is obtained for the pseudoscalar octet and for the vector octet, defining the octet base as the products of spinor variables. (L.B.S.)

29247 DUAL CROSSING SYMMETRIC MODELS WITH REGGE CUTS. Tucker, R. W. (Univ. of Massachusetts, Amherst); Zakrzewski, W. J. Nucl. Phys.; B40: 173-89 (1972).

A class of dual crossing symmetric models which generate an infinite series of Regge cuts is investigated. The amplitudes contain Regge poles dual to finite width resonances and multi-reggeon cuts dual to multi-resonance cuts. The analyticity and asymptotic behavior associated with these models are discussed and it is indicated how the pomeron might be incorporated. (auth)

29248 APPLICATION OF INFORMATION THEORY TO HIGH-ENERGY INCLUSIVE PHENOMENOLOGY. Chao, Y.-A. (Univ. of Copenhagn). Nucl. Phys.; B40: 475-98(1972).

Based on the concept of information entropy a systematic scheme of doing high-energy inclusive phenomenology is proposed. Established or presumed dynamical features are taken as constraints under which the information entropy is maximized to make the most unbiased estimation of the square of the transition amplitude. Inclusive experimental data are then to be compared with the estimated distributions to see if the data provide us with more dynamical information. The proton–proton reaction is taken as an example to demonstrate the use of the method. Averages of the longitudinal masses and the inelasticity are fixed as constraints. With only these two constraints, scaling, logarithmic increase of the average multiplicity, the difference of the transverse momentum distributions for proton and pion, an exponentially decreasing Feynman scaling function for the pion and a slowly increasing scaling function for the proton are found. The results are in good agreement with experimental measurements and thus suggest that the important dynamical information in single-particle inclusive experiments are the sharp distributions of longitudinal masses and the small inelasticity. (auth)

29249 DISTRIBUTION OF THE SPINS OF THE RESONANCES IN THE DUAL-RESONANCE MODEL. Struminskii, B. V. (Inst. of for Theoretical Physics, Kiev). Lett. Nuovo Cim.; 3: No. 16, 666-8(15 Apr 1972).

The spin distribution function for resonances in the dual resonance model is calculated in the analytical form, making no approximations except that the number of level N tends to infinity. (L.B.S.)

29250 COLLINEAR ALGEBRA FOR THE DUAL MODEL. Brower, R. C.; Goddard, P. (CERN, Geneva). Nucl. Phys.; B40: 437-44(1972).

The results of Del Giudice, Di Vecchia and Fubini are formulated in terms of the algebraic properties of their "photon" transition operator A_n^i for the $\alpha_0 = 1$ dual model. These are combined with the longitudinal (A_n^L) and scalar (Φ_n) operators to form a nice closed (spectrum generating) algebra (for collinear "photons", $k_i = kn_i$) similar to the Virasoro gauge algebra for L_n. The underlying algebraic structure allows more independent physical states to be constructed. (auth)

29251 NONLOCAL REGGE POLE THEORY. Tran Hu'u Phat (Hanoi Univ., North Viet Nam). Acta Phys. Acad. Sci. Hung.; 30: No. 4, 381-8(1971).

Nonlocal theory is applied to study the strong interaction at very high energies. The Regge poles are considered in a nonlocal S-matrix theory. The S-matrix satisfying unitarity on the mass shell, relativistic covariance and macrocausality is established. The form factor characterizing the nonlocality is found by using the asymptotic behavior of scattering amplitudes for $E \to \infty$ and the requirement that the total sections of elastic scattering tend to constant limits as $E \to \infty$. (auth)

Strong (Baryon No. = 0)

29252 (CEA-N-1513) REGGE TRAJECTORIES AND THE ROLE THEY PLAY IN THE DYNAMICS OF CERTAIN REACTIONS. Derem, Andre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan 1972. 49p. (In French). Dep. NTIS (U. S. Sales Only).

An attempt is made to indicate the most important results concerning the identity of mesonic and baryonic Regge trajectories and their classification. Structures with fixed t or u values were observed in the experimental data and associated with particular values of the exchanged trajectories; the structures are stated for certain well established two-body reactions. Two different approaches are used in order to find relations between the mesonic and baryonic trajectories, many different formulas being established for the square of the mass of the particles. Possible developments of such hypotheses are briefly examined. (France)

29253 (DESY-72/3) QUARK LOOP DYNAMICS AND MESON DECAYS. Suura, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)); Young, Bing-Lin (Ames Lab., Iowa). Feb 1972. 30p. Dep. NTIS.

From a set of lowest-order quark loop diagrams for static mesonic amplitudes involving vector and axial-vector vertices, the effective quark mass and the meson-quark-quark coupling constants are determined for three types of quark models. These parameters are applied to evaluate certain mesonic decays and the SU_3 mass splitting of 0^- octet and 1^- nonet, which serve as tests for the quark models. Adler's low-energy theorem for the $\pi^0 \to 2\gamma$ decay is derived in the approach without invoking the Adler–Schwinger anomaly. The test favors the Nambu–Han model of integrally charged quarks. Critical examinations of the underlying assumption of the quark loop dominance are made, and a speculation on a physical model which allows such a situation is proposed. (auth)

29254 (DESY-72/8) SECOND-ORDER EFFECTS IN CHIRAL-INVARIANT PION LAGRANGIANS AND THE USE OF SUPERPROPAGATORS. Lehmann, H.; Trute, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Feb 1972. 19p. Dep. NTIS (U. S. Sales Only).

The second-order corrections to the scattering amplitude and to the vector currents for chiral-invariant Lagrangians of massless pions are examined. Standard renormalization theory leads to three undetermined parameters. The possibility of choosing definite values for these parameters by applying the technique of superpropagators is discussed. The restrictions on the Lagrangian which follow if localizability is required are investigated. It is shown that this condition determines the pion field coordinates uniquely. (auth)

29255 (NP-19241) ELEMENTARY PION WITH TRANSVERSE MOMENTUM CUT-OFF. Note No. 342. Lusignoli, M.; Srivastava, Y. (Rome Univ. (Italy). Istituto di Fisica). 18 Nov 1971. 13p. Dep. NTIS (U. S. Sales Only).

The puzzle of peaks in π-exchange processes is resolved in terms of an elementary pion with transverse momentum cut-off. In np CEX for instance, this implies keeping both t and U channel π exchanges. A quantitative fit is obtained for this process maintaining ρ-A_2 exchange degeneracy. The quality of the fit is in general comparable with (if not better than) the strong cut model with less than half the number of parameters. (auth)

29256 (RLO-1388-622) FACTORIZABLE DUAL RESONANCE MODEL WITHOUT TACHYONS. Sukhatme, U.; Yu, S. (Washington Univ., Seattle). [1971]. 10p. Dep. NTIS.

A dual resonance amplitude containing trajectories with positive intercepts but no tachyons is proposed. The model factorizes, and has a nondegenerate leading trajectory starting at spin two. (auth)

29257 COMPARISON OF ELASTIC $(\bar{p}p,pp)$, (K^-p,K^+p), AND (π^-p,π^+p) SCATTERINGS AT ~8 AND 16 GeV/c. Gordon, Howard A.; Lai, Kwan-wu; Paige, Frank E. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 5: No. 5, 1113-16(1 Mar 1972).

Experimental data of $(\bar{p}p,pp)$, (K^-p,K^+p), and (π^-p,π^+p) elastic scatterings at ~8 and 16 GeV/c are examined in the context of the dual absorption model (DAM) as proposed by Harari. Results of this analysis of $(\bar{p}p,pp)$ and (K^-p,K^+p) exhibit similar behavior as expected from DAM and thus support the model. The behavior of (π^-p,π^+p), however, shows a marked difference from the other systems. An explanation for this difference is presented. (auth)

29258 COMMENT ON THE PROTON–ANTIPROTON ANNIHILATION CROSS SECTION AT LOW ENERGY. Bizzarri, R. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Guidoni, P.; Marzano, F.; Castelli, E.; Sessa, M. Phys. Rev., D; 5: No. 5, 1217-19(1 Mar 1972).

It is pointed out that the recent measurements of the low-energy $\bar{p}p$ annihilation cross section by Cline et al. must be heavily contaminated by annihilations of stopping antiprotons and therefore the resulting cross section is grossly overestimated. Brief remarks are given on the "antishrinkage" observed in the low-energy $\bar{p}p$ elastic scattering. (auth)

29259 COMMENTS ON ANALYSES OF $\bar{p}n \to 3\pi$. Gleeson, A. M. (Univ. of Texas, Austin); Meggs, W. J.; Parkinson, M. T. Contracts ORO-3992; AT(30-1)-875. Phys. Rev., D; 5: No. 5, 1224-6(1 Mar 1972).

The analysis of the reaction $\bar{p}n \to \pi^+\pi^-\pi^-$ using the rising-shift model is compared with attempts to explain the data with the Veneziano model. The fact that daughter trajectories are not parallel to the leading trajectory is emphasized. (auth)

29260 SPECTRAL FUNCTION SUM RULES FROM CURRENT ALGEBRA, UNITARITY, AND ANALYTICITY. Ecker, G. (CERN, Geneva). Nucl. Phys.; B39: No. 1, 267-84(1972).

With the assumptions of SU(2) × SU(2) current algebra, conservation of the vector currents, PCAC and finiteness of the Schwinger terms C_V and C_A, some restrictions of unitarity and analyticity on hard pion current algebra models are obtained for the specific case of the pion form factor. Among the results are a representation for the proper vertex of the vector current between pion states, the Kawarabayashi-Suzuki-Fayyazuddin-Riazuddin relation and other spectral function sum rules. In the case of polynomial models for the proper vertices, a lower bound on C_V and an upper bound for the ρ width are derived, and estimates are made of corrections to ρ pole dominance of the vector current spectral function. (auth)

29261 NUCLEON–ANTINUCLEON ELASTIC SCATTERING WITH INELASTIC EFFECTS: S-WAVE PHASE-SHIFTS. Aldrovandi, R.; Caser, S. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B39: No. 1, 306-16(1972).

The OBE model for $N\bar{N}$ elastic scattering is improved by including inelasticity at a phenomenological level in a pure S-matrix formulation. In this way it is possible to find the π and η poles at their physical masses. The corresponding phase shifts are computed and shown to be remarkably independent of the inelasticity parameters. (auth)

29262 NUCLEON–ANTINUCLEON ANNIHILATION AT REST AND HADRONIC PRODUCTION IN e^+e^- ANNIHILATION AT 1.9 GeV. Pelaquier, E.; Renard, F. M. (Departement de Physique Mathematique, Montpellier, France). Nucl. Phys.; B39: No. 1, 547-56(1972).

The $\bar{N}N$ annihilation at rest is analyzed with the help of a meson dominance model. The hadronic production coming from the $^3S_1$ state ($J^{PC} = 1^{--}$) is then used for predicting the corresponding production in e^+e^- annihilation at the same total energy. A comparison is done with the Frascati results and with the ones of other specific theoretical models. (auth)

29263 ISOSPIN ANALYSIS OF THE REACTION: $\bar{N}N \to 3\pi$. Bjoerneboe, Jens (Univ. of Copenhagen). Nucl. Phys., B40: 445-56(1972).

A method of isospin analysis of the reaction $\bar{N}N \to 3\pi$ is proposed, which involves only integrated cross sections of the two measurable channels: $\bar{p}p \to \pi^-\pi^0\pi^+$ and $\bar{p}n \to 2\pi^-\pi^+$. The implications of charge conjugation and the case of annihilation at rest are considered in some detail. (auth)

29264 PION p_t AND p_l DISTRIBUTIONS IN HIGH-MULTIPLICITY INTERACTIONS. Ijaz, M. A. (Virginia Polytechnic Inst. and State Univ., Blacksburg); Kephart, T. W.; Moore, G. E.; Sample, W. M.; Munir, B. A. Nuovo Cim.; 8A: No. 4, 778-86 (21 Apr 1972).

An analysis was made of p_t and p_l distributions of pions produced in some high-multiplicity reactions at accelerator energies. It is found that pion p_t distributions are best fitted by the Hagedorn model as compared with the Maxwell-Boltzmann distribution. The c.m.s. p_l distributions were analyzed in terms of an exponential function and the two-temperature model of Wayland and Bowen.

The agreement of the data with the distributions used in fitting is fair. Feynman's limiting-distribution hypothesis was examined by fitting the c.m.s. p_l distribution to a function $f(p_l) = A/\sqrt{p_l^2 + B}$, where A and B are constants. Within a limited range of p_l it appears that there is some evidence for the scaling hypothesis even at the present accelerator energies. (auth)

29265 RIVAL MODELS FOR TOTAL CROSS SECTIONS. Barger, V. (Univ. of Wisconsin, Madison); Phillips, R. J. N. Contract AT(11-1)-881. Nucl. Phys.; B40: 205-20(1972).

New Serpukhov data, with positive beams, are incorporated in a reanalysis of πN, KN, $\bar{K}$N, NN and $\bar{N}$N total cross sections. Pomeron cut, dipole and Cheng–Wu forms are considered for the leading Pomeranchuk term; secondary terms are approximated by ω, f, ρ and A_2 Regge poles. The possibility $\alpha_P < 1$ is also considered. Extrapolations of the rival models are compared, in the NAL and ISR energy ranges, where measurements are expected soon. The qualitative difference between nucleon–nucleon and meson–nucleon behaviors is considered; a clue is found in the energy scale of the logarithmic term in pomeron cut models, that proves to be proportional to the incident particle mass. Relations between cross section differences, following from ω universality, SU(3) and ρ–A_2 exchange–degeneracy, are shown to be well satisfied. f–ω exchange–degeneracy is model-dependent, since assumptions about the Pomeranchuk term affect the empirical f parameters. The implications of imposing f–ω exchange degeneracy, as a theoretical constraint, are discussed. (auth)

29266 K-MESON RESONANCES IN THE ENERGY REGION 1700 TO 2000 MeV. Dal'karov, O. D.; Mandel'tsveig, V. B. JETP Lett. (USSR) (Engl. Transl.); 10: No. 9, 275-7(5 Nov 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 10: No. 9, 429-32(5 Nov 1969).

Nonrelativistic bound states in the NΛ system, that is, quasinuclear levels with a binding energy small compared with the mass of the particles contained in the system, are investigated. The level widths of the various K* resonances in the 1700 to 2000 MeV region are discussed. (J.F.P.)

29267 DUAL QUARK MODELS. Dietz, K. (Univ., Bonn). Springer Tracts Mod. Phys.; 60: 74-90(1971).

In these lectures the scattering of parton compounds is considered. Bound states and resonances are required to follow the same composition laws as the ones used to build up the reacting particles. Mesons which are taken to be quark–antiquark compounds are mainly considered. Quark diagrams, the inclusion of quark spin, L excitations, and the elimination of ghosts are discussed. (J.F.P.)

29268 NARROWING OF DIFFRACTION CONE AND SLOPE OF POMERANCHUK TRAJECTORY. Ter-Martirosyan, K. A. JETP Lett. (USSR) (Engl. Transl.); 10: No. 9, 285-9(5 Nov 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 10: No. 9, 445-50(5 Nov 1969).

The dependence of $b(\epsilon)$ on energy in the relation $\ln(d\epsilon/dt_k^2) = C - b(\epsilon)k^2$ is considered with allowance for the contributions of several poles and branch points for strong interactions. It is shown that the branch points hardly change the effective slope. (J.F.P.)

29269 $\pi\pi$ THEORIES. Basdevant, J. L. (CERN, Geneva). Springer Tracts Mod. Phys.; 61: 1-24(1972).

A brief review is given of the structure of $\pi\pi$ theories. The topics discussed are rigorous results, integral equations, bootstrap, duality, and the Pade approximation. (J.F.P.)

Strong (Baryon No. = 1)

Refer also to abstracts 29163 and 29340.

29270 (COO-1195-222) PARTIAL WAVE ANALYSIS IN MESON SPECTROSCOPY. Kruse, U. E. (Illinois Univ., Urbana). Jul 1971. Contract AT(11-1)-1195. 17p. (CONF-710721-2). Dep. NTIS.

From Meson spectroscopy workshop; Argonne, Ill. (Jul 1971).

Research on the 3π decay models of the A_1, A_2, and A_3 mesons is reviewed for the reactions $\pi^+ + p \rightarrow p + 2\pi^+ + \pi^-$ at 5 to 8.5 GeV/c and $\pi^- + p \rightarrow p + 2\pi^- + \pi^+$ at 5 to 25 GeV/c. In this partial-wave analysis an attempt was made to separate out the various spin parity components contributing to these spectra and to determine the decay modes of the spin parity states. (J.F.P.)

29271 (COO-3065-3) DYNAMICAL MECHANISM FOR THE DIFFRACTIVE DISSOCIATION REACTION $\pi \rightarrow 5\pi$. Celik, Tarik; Meggs, William J. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). 25 Jan 1972. Contract AT(11-1)-3065. 21p. (UR-371). Dep. NTIS.

A dynamical mechanism based on the multi-Regge model and duality is used to investigate the diffractive dissociation reaction $\pi \rightarrow 5\pi$. The requirement that the peak in the five-pion mass distribution be independent of energy leads to a determination of the multi-Regge parameters as well as the mass and width of the enhancement. (auth)

29272 (FRNC-TH-142) INVESTIGATION OF THE PHOTOPRODUCTION OF K MESONS USING AN ISOBAR MODEL. Renard, Yvette (Montpellier Univ. (France)). 1971. 183p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The photoproduction of K mesons was studied using an isobar model containing the Born terms and all the currently known resonances which might intervene in the s and u channels. It is shown that it is possible to construct, in a simple way, the relativistic invariant coupling and gauge invariance as well as the propagators for particles of indeterminate spin. The relative amplitudes are described for each term; they are decomposed for the four invariants corresponding to the production of π mesons. The results of the analysis are compared with those obtained experimentally. The experimental results on the differential cross sections corresponding to the $\gamma + p \rightarrow K^+ + \Lambda$ and $\gamma + p \rightarrow K^+ + \Sigma^0$ are smoothed. (France)

29273 (LYCEN-7172) POLARIZATION PARAMETERS AND RECONSTRUCTION OF AMPLITUDES FOR π–N SCATTERING.—Giffon, M. (Lyon Univ. (France). Institut de Physique Nucleaire). 6 Oct 1971. 38p. Dep. NTIS (U. S. Sales Only).

The various π–N scattering amplitudes are reconstructed from recently measured values of the polarization parameters for elastic π^-p scattering. The Regge model and the F.E.S.R. (finite energy sum rules) are compared. Predicted values for the A and R parameters for π^+p elastic and charge-exchange scattering are given. (France)

29274 (RLO-1388-610) ADLER–WEISBERGER THEOREM RE-EXAMINED. Brown, Lowell S.; Pardee, W. J.; Peccei, R. D. (Washington Univ., Seattle. Dept. of Physics). [1971]. 36p. Dep. NTIS.

The nature of the current algebra constraints on the on-mass-shell amplitudes of pion-nucleon scattering at $s = m_N^2$, $t = 2m_\pi^2$ is considered. It is proven that, at this point, an even amplitude is determined up to corrections of order m_π^4 and that the corrections to an odd amplitude are of order m_π^2. Thus, the σ-term in the even amplitude, which is of order m_π^2, can be determined, confirming the recent work of Cheng and Dashen. However, such a determination cannot be made with a mixture of even and odd amplitudes as von Hippel and Kim have attempted to do. The actual magnitude of the corrections is estimated from what should be the dominant physical mechanisms: the large nucleon size and the proximity of the strong 3-3 resonance state. These corrections are insignificant for the even amplitude. For the odd amplitude they are separately large, about 10%, but they cancel for the most part and give a much smaller contribution. Corrections due to other resonances are insignificant compared to the 3-3 contribution. The Adler–Weisberger theorem, with the on-shell method, relates the pion-nucleon coupling constant f to the pion decay constant and an integral over the absorptive part of the physical π-N scattering amplitude; it does not involve the axial-vector coupling constant g_A. It is found that this relation gives $f^2 = 0.077$ which is to be compared to direct evaluations that range from $f^2 = 0.082$ to $f^2 = 0.076$. It is concluded that these current algebra theorems may well be satisfied to a considerable degree of accuracy. More precise low-energy pion-nucleon scattering data are needed, however, for a definitive test. (auth)

29275 (RLO-2041-66) LONGITUDINAL AND TRANSVERSE MOMENTUM CORRELATION OF THE PROTON SPECTRUM. Hwa, Rudolph C. (Oregon Univ., Eugene). Jan 1972. Contract AT(45-1)-2230. 12p. Dep. NTIS.

The inclusive proton spectrum in the region $0.5 \lesssim x \lesssim 0.9$ is described by a through-going proton recoiling against a high-mass cluster. The longitudinal and transverse momentum correlation can then be explained in terms of a simple Regge formula. Evidence is given for the weakness of the triple-Pomeron coupling. (auth)

29276 (RLO-2041-68) QUESTION OF BLACK-BODY RADIATION IN INCLUSIVE REACTIONS IN THE WEE-X REGION. Hwa, Rudolph C.; Robertson, David C. (Oregon Univ., Eugene. Inst. of Theoretical Science). Mar 1972. Contract AT(45-1)-2230. 18p. Dep. NTIS.

The one-particle distribution function in the wee-x region is derived in the diffractive excitation model. The result describes very well the "isotropy" and "Bose-Einstein" distribution of the 11.8 GeV/c K^+p data on inclusive reactions in that region. There is no need for the postulation of "black-body radiation." It is

shown that the phenomenon should disappear at asymptotic energies. (auth)

29277 DO REGGE POLE-CUTS ACCOUNT FOR $\Delta\sigma_T(\pi p)$. Hanson, Ronald W. (Arizona State Univ., Tempe). Phys. Rev., D; 5: No. 5, 1227-8(1 Mar 1972).

The difference between $\sigma_T(\pi^+p)$ and $\sigma_T(\pi^-p)$ tends to level off around 40 GeV/c. Recent articles have contended the Regge pole-cuts can account for this trend. The calculations from a previous paper on π^-p charge-exchange scattering are extended to $\Delta\sigma_T(\pi p)$. It is found that the Regge pole-cut model does not improve the single-Regge-pole predictions to the high-energy end of $\Delta\sigma_T(\pi p)$. (auth)

29278 COMPARISON OF ON- AND OFF-MASS-SHELL π^-p ELASTIC AND INELASTIC SCATTERING. Galloway, K. F. (Indiana Univ., Bloomington); Mercer, R. A.; Cason, N. M.; (and others). Phys. Rev., D; 5: No. 5, 1097-1100(1 Mar 1972).

One-pion-exchange (OPE) dominance is examined in the reactions $\pi^-p \to \rho^0\pi^-p$ and $\pi^-p \to \rho^0\pi^-\pi^0p$ at 6 and 8 GeV/c. On-mass-shell and off-mass-shell scattering angular distributions for $\pi^-p \to \pi^-p$ and $\pi^-p \to \pi^-\pi^0p$ are compared. The data substantiate the use of the OPE model in reactions such as $\pi^-p \to \rho^0\pi^-p$ and demonstrate that the model can be extended to reactions such as $\pi^-p \to \rho^0\pi^-\pi^0p$. (auth)

29279 WAY TO TEST CAUSALITY IN THE ρ-MESON SYSTEM. Creutz, Michael (Univ. of Maryland, College Park). Phys. Rev., D; 5: No. 5, 1139-43(1 Mar 1972).

It is shown how to determine experimentally if the ρ meson is a normal pole in the second sheet of the energy plane as opposed to a noncausal pole in the first sheet. This determination uses electromagnetic corrections to the reaction $\pi^-p \to \pi^+\pi^-n$. It is found that for certain kinematics the ρ mesons produced in this reaction will appear to be shifted in mass in a direction controlled by the position of the ρ pole. For an 8 to 10 GeV beam energy, 4% of the events will be shifted by roughly 1 to 2 MeV. (auth)

29280 DUAL FEATURES OF $\bar{K}-N$ ELASTIC SCATTERING AMPLITUDES. Berthon, A.; Jacob, M.; Meyer, J.; Moeller, R.; Plane, D. E. (CERN, Geneva). Nucl. Phys.; B39: No. 1, 1-6 (1972).

The conjectures of Freund and Harari, together with s-channel helicity conservation in diffraction are shown to stand the tests now available in the $\bar{K}-N$ channel. The relevant amplitudes were obtained through a partial wave analysis in the c.m. energy range from 1.55 to 2.14 GeV. Some evidence for the existence of P_{01} and S_{11} resonances is discussed. (auth)

29281 DIFFRACTIVE $\pi\pi$ SCATTERING IN $\pi N \to \pi\pi N$ AT 13.1 (GeV/c). Gaidos, J. A.; Gutay, L. J.; Kramer, S. L.; (and others) (Purdue Univ., Lafayette, Ind.). Nucl. Phys.; B39: No. 1, 7-12 (1972).

Data on diffractive $\pi\pi$ scattering in the reactions $\pi^+p \to \pi^+\pi^0p$, $\pi^+\pi^+n$ and $\pi^+n \to \pi^+\pi^-p$ are presented and discussed in terms of a factorized double-exchange model involving OPE and Pomeranchuk plus exchange-degenerate ρ, f contributions. (auth)

29282 REACTION $K^-p \to \omega\Lambda$ IN THE C.M. ENERGY RANGE 1915 TO 2168 MeV. Brandstetter, A. (Rutherford High Energy Lab., Chilton, Eng.); Butterworth, I.; Deen, S. M.; (and others). Nucl. Phys.; B39: No. 1, 13-38(1972).

A bubble chamber study was made of the reaction $K^-p \to \omega\Lambda$ at 13 momenta in the c.m. energy range 1915 to 2168 MeV. Differential cross sections are presented together with Legendre polynomial expansions of these and of the single and joint density matrices. An energy dependent partial wave analysis is carried out yielding evidence for resonance formation. The $G_{91}\Lambda(2100)$ is found to have a small $\omega\Lambda$ branching ratio. (auth)

29283 CRITICAL TEST OF MODELS FOR THE LOW ENERGY πN AMPLITUDE. Hoehler, G.; Jakob, H. P.; Strauss, R. (Univ., Karlsruhe, Ger.). Nucl. Phys.; B39: No. 1, 237-66(1972).

Starting from fixed-t dispersion relations, phase shifts and total cross sections, the coefficients of an expansion of the invariant πN-amplitudes at the crossing symmetry point are calculated, considering the nucleon pole term and the $\Delta(1232)$-exchange contribution separately. A similar calculation is made for an expansion at threshold. The results are compared with predictions from models based on Ward identities and phenomenological Lagrangians. Limitations and ambiguities of treating Δ-exchange by a pole term are discussed and the magnitude of effects is estimated, which are not included in the models. In many cases our conclusions differ from those of earlier authors. (auth)

29284 PHENOMENOLOGICAL COMPARISON OF CERTAIN HIGH-ENERGY SCATTERING MODELS. Bourrely, C.; Scott, W. Grant (Cambridge Univ., Eng.). Nucl. Phys.; B39: No. 1, 285-305(1972).

On the basis of χ^2 evaluation, using total cross section data up to 70 GeV/c including that recently reported at the Amsterdam Conference, it is difficult to distinguish between many phenomenological models which have been proposed for its explanation. In particular it is shown, that on the basis of the data, that models which violate the Pomeranchuk theorem, are no more likely than the others. Interesting consequences of violation of the Pomeranchuk theorem are examined for a particular model, and pion nucleon differential cross sections are predicted in the Coulomb interference region. The possibility of decisive tests of the Pomeranchuk theorem violating models in this region is examined. (auth)

29285 LONGITUDINAL PHASE SPACE AND HELICITY CONSERVATION IN DIFFRACTIVE RESONANCE PRODUCTION. Meunier, J.-L.; Plaut, G. (Univ., Nice). Nucl. Phys.; B39: No. 1, 557-71(1972).

Recent experimental results on helicity conservation in A_1 production are examined using a Reggeized Deck model similar to that proposed by Berger. It is shown that this model, which conserves neither s-channel nor t-channel helicity, is able to reproduce the isotropic azimuthal distributions found experimentally, when the events are selected according to their location on a longitudinal phase space (LPS) plot. The approximate isotropy of these distributions cannot be considered as conclusive evidence in favor of helicity conservation, and it pointed out that the "LPS-selection" of events can hide important features of the experimental results. (auth)

29286 INCLUSIVE CROSS SECTIONS OF MEDIUM-ENERGY KAON REACTIONS. Blokzijl, R. (Zeeman-Laboratorium, Amsterdam); de Groot, A. J.; Kluyver, J. C.; (and others). Nucl. Phys.; B39: No. 1, 141-8(1972).

The characteristics of the neutral kaons produced in the reaction 4.2 GeV/c $K^- + p \to \overline{K}^0 +$ anything are compared with data at other momenta. A survey is made of medium-energy inclusive cross sections obtained by postulating $\sigma_T(K^-p) = \sigma_-(K^-) + \sigma_-(\overline{K}^0) + \sigma_-(Y)$. The inclusive cross sections $\sigma_-(K^-)$ and $\sigma_-(\overline{K}^0)$ are found to be constant as functions of the incoming kaon momentum. Moreover, a comparison with inclusive K^+ production in the reaction $K^+ + p$ shows $\sigma_-(K^-) \approx \sigma_+(K^+) \approx 11.7$ mb. (auth)

29287 EXOTIC ATOMS. Kim, Y. N. (Texas Tech. Univ., Lubbock). Phys. Bull. (London); 23: 148-50(Mar 1972).

The existence of exotic (i.e. muonic, mesonic, hyperonic and antiprotonic) atoms (or mesic atoms) is now well established. The study of exotic atoms although encompassing atomic, molecular, nuclear and elementary particle physics is most extensively used as a source of information on nuclear structure. The modes of energy loss of negative mesons in matter are given and the energy levels of mesic atoms discussed. The special features of muonic atoms, muonic molecules, muonium, pionic and kaonic atoms, and sigmic and antiprotonic atoms are examined. Biomedical and other uses of exotic atoms are considered. (UK)

29288 DISPERSION RELATION INVESTIGATION OF HIGH-ENERGY Kp FORWARD SCATTERING AMPLITUDES AND OF Kp ASYMPTOPIA USING RECENT CROSS-SECTION DATA. Meyer, R. W. (Univ., Amsterdam); Winzeler, H. Nucl. Phys.; B40: 417-27(1972).

Comparison of computed results on the ratio α_+ of real and imaginary parts of the elastic forward scattering amplitude for K^+p with experiment can disqualify an approach of σ_{K^+p} and σ_{K^-p} like $p^{-0.5}$ at asymptotic momenta. However, an approach like $p^{-0.14}$ can be well reconciled with experiment. The corresponding computed values for K^-p scattering indicate a still considerable real part in the multi GeV region. It is further shown that, independently of how well one has fitted the low-energy parameters, it is practically impossible to distinguish experimentally between Pomeranchuk theorem validity and nonvalidity at energies even as high as 100 GeV. Also the assumption of a logarithmic asymptotic rise for the total cross sections does not lead to drastically different results. Therefore, as for πp scattering, also here the dispersion relations do not provide the crystal ball revealing the secrets of asymptopia. (auth)

29289 NEW πN PHASE-SHIFT ANALYSIS. Almehed, S. (Lund Univ., Sweden); Lovelace, C. Nucl. Phys.; B40: 157-72 (1972).

The 1967 CERN-EXP phase-shift analysis was redone with $2\frac{1}{2}$ times more experimental data (11,550 points). The results differ mainly in being even smoother. Most of the previous resonance candidates are strengthened, and four possible new ones above 2 GeV suggested. However, the $D_{13}(1700)$ required by the quark model is still absent. (auth)

29290 SCALING OF MULTIPLICITY DISTRIBUTIONS IN HIGH ENERGY HADRON COLLISIONS. Koba, Z.; Nielsen, H. B.;

Olesen, P. (Univ. of Copenhagen). Nucl. Phys.; B40: 317-34 (1972).

It is shown that asymptotically $\langle n \rangle \sigma_n(s)$ is only a function of $n/\langle n \rangle$, where $\sigma_n(s)$ is the multiplicity distribution. The essential assumption in deriving this result is that multiparticle inclusive cross sections obey the scaling law. It is also pointed out that the available data below 30 GeV may possibly indicate rather long-range correlations in multibody reactions. (auth)

29291 HIGH ENERGY SCATTERING AND CHARGE EXCHANGES IN THE COMPLEX ANGULAR MOMENTUM THEORY. Boreskov, K. G.; Lapidus, A. M.; Sukhorukhov, S. T.; Ter-Martirosyan, K. A. (Inst. for Theoretical and Experimental Physics, Moscow). Nucl. Phys.; B40: 307-16(1972).

The techniques of complex angular momentum theory including Regge poles and cut contributions are used to fit all existing experimental data for $\pi^{\pm}N$, $K^{\pm}N$ and NN, and $\bar{N}N$ scattering and charge exchange processes. (auth)

29292 REGENERATION $K_1^0 \rightarrow K_2^0$ ON NUCLEONS IN THE COMPLEX ANGULAR MOMENTUM THEORY. Lisin, V. I.; Sukhorukov, S. T.; Ter-Martirosyan, K. A. (Inst. for Theoretical and Experimental Physics, Moscow). Nucl. Phys.; B40: 298-306(1972).

With the account of Regge poles and all cut contributions the curves of the energy dependence of the regeneration cross section $(d\sigma_{12}/dt)_{t=0} = f(E)$, of the phase of the regeneration amplitude φ_{12} and of the total $K^{\pm}N$ cross sections are obtained. On an example of a simple model it is shown that the Pomeranchuk theorem violation considerably changes these dependences, especially the regeneration amplitude phase φ_{12}. (auth)

29293 FINITE-TRANSFORM SUM RULE AND DUALITY. Chavda, L. K. (Univ. of Alberta, Edmonton). Nuovo Cim.; 8A: No. 4, 722-34(21 Apr 1972).

Explicit relationships are established between the finite-transform sum rules derived previously and the finite-energy sum rule. The sine sum rule is applied to the pion-nucleon charge-exchange scattering in the forward direction. The assumption that the ρ trajectory alone dominates the charge-exchange amplitude leads to conflicts with analyticity even at 6 GeV. In the limit of the zero-mass pion the Born term in the sum rule is shown to be cancelled for all values of the continuous moment by a secondary trajectory with the intercept $\alpha' = -1$ and the reduced residue $\gamma' = -\pi f^2$, where f^2 is the pion-nucleon coupling constant. This secondary trajectory removes the conflict with analyticity at 6 GeV. Such a cancellation is a common feature of at least five sum rules. The local and global dualities are found to be violated whether or not the systematic errors are used and whether or not the Born term is substracted out by means of the secondary trajectory. However, the usual low-mass resonances with well-determined quantum numbers satisfy the dualities better than the higher-mass resonances with mass > 2.62 GeV. The CERN-Serpukhov data are amenable to the Regge-pole description and are consistent with the Pomeranchuk theorem due to their large errors. (auth)

29294 PROBLEM OF THE SIGMA TERMS IN MESON–BARYON SCATTERING: COMMENTS ON RECENT LITERATURE. Renner, B. (Univ., Hamburg). Springer Tracts Mod. Phys.; 61: 120-9(1972).

A recent controversy about the value of the sigma term in pion-nucleon scattering is reviewed, with particular attention to possible attempts to reconcile the large value of Cheng and Dashen with the $(3,3^*) + (3^*,3)$ chiral symmetry breaking model of Gell-Mann. Grounds for reservations may be found for each one of three mechanisms considered. Thus the general belief is confirmed that the conventional theory of chiral symmetry breaking cannot be easily maintained, unless the value of Cheng and Dashen is given up in favor of a reestimate by Höhler, Jakob and Strauss. (auth)

29295 DYNAMICS OF SOME πN RESONANCES. Gustafson, G.; Hamilton, J. (NORDITA, Copenhagen). Springer Tracts Mod. Phys.; 61: 49-67(1972).

A review is given of the πN resonances below 2 GeV. The use of partial wave dispersion relations is discussed including the main sequence of πN resonances, spin and charge ratios, the exchange signature, ranges and magnitudes, and the unitary limit. Other πN resonances and theories considered are the $S_{11}(1535)$, singularity structure, the $S_{31}(1650)$, the ρN hypothesis, the multi-mass formalism, other ρN S-waves, the amplitude D_{13}, speculations on ρN P-waves, and the resonance $P_{13}(1860)$. (J.F.P.)

29296 NUCLEON RESONANCES. Donnachie, A. (Univ. of Manchester, Eng.). Springer Tracts Mod. Phys.; 61: 25-48 (1972).

A review is given of nucleon resonances in scattering and photoproduction formalism, pion–nucleon two-body reactions, pseudoscalar meson photoproduction, and many-body final states. (J.F.P.)

29297 DESCRIPTION OF THE $\pi^- p \rightarrow NK\bar{K}$ REACTION IN THE GENERALIZED VENEZIANO MODEL. Budagov, Yu. A.; Vinogradov, V. B.; Enkovskii, L. L.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz.; 62: No. 3, 836-43(Mar 1972). (In Russian).

The $\pi^- p \rightarrow pK^-K^0$ and $\pi^- p \rightarrow nK^0\bar{K}^0$ reactions at 1.5 to 8 GeV/c are investigated within the framework of the generalized Veneziano model. The total and differential cross sections, effective mass distributions and angular distributions of secondary particles are calculated. The predictions are compared with the experimental data. (auth)

29298 DETERMINATION OF THE BASIC PARAMETERS OF THE 3-3 RESONANCE. Ball, James S. (Univ. of Utah, Salt Lake City); Campbell, R. Russell; Lee, Paul S.; Shaw, Gordon L. Phys. Rev. Lett.; 28: No. 17, 1143-4(24 Apr 1972).

The recent precise measurements of π-N scattering in the 3-3 energy range have been fitted by Rittenberg et al., using four different phenomenological resonance formulas. These fits yield masses in the range 1234 to 1231 MeV, with widths ranging from 112 to 120 MeV. It is shown that these fits, as well as an ND^{-1} fit, all yield a nearly unique value for the position of the 3-3 pole in the S matrix at 1211 − 50i MeV. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 29154 and 29827.

29299 (COO–3001-2) NUCLEON–NUCLEON INTERACTION AND OPTIMAL RELATIVITY. Fortes, M.; Jackson, A. D. (State Univ. of New York, Stony Brook, Dept. of Physics, Niels Bohr Institutet, Copenhagen (Denmark)). Dec 1971. Contract AT(11-1)-3001. 15p. Dep. NTIS.

The iterations of the Blankenbecler–Sugar equation are discussed, and phase shifts are calculated for superpositions of one-boson-exchange interactions. A comparison with results obtained with the Bethe–Salpeter equation shows that an essentially quantitative agreement is achieved. The relevance of these calculations is discussed in relation to current techniques employed in the derivation of two-pion-exchange contributions to the NN force. (auth)

29300 (IFVE-STF-71-9) CALCULATIONS OF THE SHADOW EFFECTS IN PROTON–DEUTERON SCATTERING. Anisovich, V. V.; Volkovitskii, P. E.; Dakhno, L. G. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1971. 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown that a summed contribution of shadow effects, connected with elastic and inelastic processes to the total cross section of proton deuteron scattering is almost constant in the energy range E_{lab} = 2 to 30 GeV. A small change of the shadow correction at E_{lab} > 15 GeV is due to inelastic processes only. This allows one to write down the following extrapolation formula $\delta\sigma = \delta\sigma_0[1 + (E_{lab} - E_0)\ b]$ for shadow corrections, where $E_0 b = (3.3 \pm 3.6) \cdot 10^{-1}\ GeV^{-1}$, E_0 = 22, 5 GeV, and $\delta\sigma_0$ are determined on the basis of the data on neuteron proton cross sections at E_{lab} = +15 to 30 GeV and equals (2.8 ± 0.3) mb. (auth)

29301 (JINR–P4-6278) ON PARAMETRIZATION OF THREE-PARTICLE REACTION AMPLITUDES. I. QUASIELASTIC DEUTERON DISINTEGRATION. Zakhar'ev, B. N.; Luk'yanov, V. K.; Titov, A. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

The possibility of parametrization of a three-particle scattering amplitude is analyzed. As a basis the three-particle amplitude expansion into a series of partial waves over hyperspherical harmonics and diffraction methods of construction of corresponding partial amplitudes are assumed. For the example of a quasielastic disintegration reaction the possibility is shown of such a simple diffraction of the three-particle scattering model. (auth)

29302 (NP–19240) ANGULAR BEHAVIOR OF THE K/π RATIO AT HIGH ENERGY IN THE MULTI-REGGE MODEL. Note No. 338. Boldrighini, C.; Lusanna, L. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 4 Oct 1971. 12p. Dep. NTIS (U. S. Sales Only).

Making use of the Cagneschi–Pignotti multi-Regge model the behavior of the K/π ratio in pp scattering as a function of $u = -\log \tan \Theta/2$, at high energy ($s \simeq 2000 - 10.000\ GeV^2$) is investigated. It is found that this behavior is practically independent of the trajectories exchanged but is strongly dependent on the damping mechanism for the perpendicular momenta of the outcoming secondaries. Good agreement with the existing cosmic ray data

is found, and predictions are made that should be easily testable at N. A. L. and I. S. R. energies. (auth)

29303 (RLO-1388-613) ON THE PARITY-VIOLATING ONE PION EXCHANGE POTENTIAL. Henley, Ernest M. (Washington Univ., Seattle. Dept. of Physics). Jun 1971. 10p. Dep. NTIS.

It is argued that the strangeness-conserving weak currents can contribute to the single-pion-exchange parity-violating potential between nucleons bound in nuclei. Although this $\cos^2\Theta$ (Θ = Cabbibo angle ≈ 0.22) contribution is reduced by $V_{nuclear}/M \sim 0.04$, it may be comparable in strength to that usually calculated, which is proportional to $\sin^2\Theta \approx 0.05$. The omission of these terms might be able to account for some of the differences between recent theoretical calculations and nuclear parity-violation experiments. Estimates of the strength of an off mass shell $NN\pi$ and of a $N^*N\pi$ vertex are carried out; it is shown that the $\Delta(1236)N\pi$ weak vertex can be neglected. Neutral pion emission is allowed at the $N^*N\pi$ and $NN\pi$ off mass shell vertices, so that the weak n-n and p-p force effects should be present to the extent SU(3) is broken. (auth)

29304 (RLO-1388-628) CHARGE SYMMETRY BREAKING AND N-N SCATTERING LENGTHS. Henley, E. M.; Kelliher, T. E. (Washington Univ., Seattle. Dept. of Physics). [1971]. 23p. Dep. NTIS.

Recent experimental and theoretical investigations of ρ-ω and η-π mixing have caused one to reexamine the effects of these mixings on the charge symmetry breaking of nuclear forces. The charge asymmetry of the nucleon-nucleon force in the singlet S-state is used to predict the n-n scattering length in terms of the measured p-p one. The extra attraction of the n-n potential in the $^1S_0$ state gives rise to a change of roughly -0.8 fm in the corresponding scattering length. The magnitude (and sign) of the charge asymmetry is approximately that required to understand the binding energy differences of the mirror nuclei $^3He-^3H$ and $^{41}Sc-^{41}Ca$. (auth)

29305 (RLO-1388-632) STRUCTURE OF THE INCLUSIVE PION SPECTRUM NEAR x = 0. Pignotti, A. (Brookhaven National Lab., Upton, N. Y. Washington Univ., Seattle); Ripa, P. (Washington Univ., Seattle). [1971]. 12p. (BNL-16120). Dep. NTIS.

Using a simplified multiperipheral model the behavior of the longitudinal pion spectrum is studied for the process $pp \rightarrow \pi +$ anything in the region of small values of $x = 2p_{\parallel}^{cm}/(s)^{\frac{1}{2}}$. The occurrence of an inverted cusp in the spectrum at very large energies and the appearance of noticeable effects at the energies of the CERN intersecting storage rings are expected. (auth)

29306 DIFFRACTION-DISSOCIATION MODEL OF HIGH-ENERGY NUCLEON-NUCLEON INTERACTIONS. Adair, Robert K. (Brookhaven National Lab., Upton, N. Y. Yale Univ., New Haven). Phys. Rev., D; 5: No. 5, 1105-13(1 Mar 1972).

A model, discussed previously, where high-energy nucleon-nucleon interactions are considered from the view that diffraction-dissociation processes may be dominant at high energies, is used to calculate production multiplicities and meson and nucleon momentum spectra for proton-proton interactions at laboratory energies between 30 and 1500 GeV. (auth)

29307 σ-EXCHANGE POTENTIAL FOR NUCLEON-NUCLEON SCATTERING. Partovi, Firooz; Lomon, Earle L. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 5: No. 5, 1192-1205(1 Mar 1972). Contract AT(30-1)-2098.

A nucleon-nucleon interaction potential is derived which includes all exchanges between a pair of nucleons involving a single σ meson and any number of pion-pair inserts on the σ-meson propagator and vertices. The reduction of the Bethe-Salpeter kernel to a potential follows the method of Partovi and Lomon. The σ-pion and σ-nucleon couplings are restricted by the Adler chiral condition at zero four-momentum transfer, renormalized. The σ-meson mass is taken from experimental evidence to be nearly M_ρ. Various σ-meson widths are considered. Widths greater than 300 MeV predict small σ-meson contributions to the potential due to persistent cancellations between graphs. In particular near the width of about 610 MeV predicted by Weinberg's asymptotic restrictions the σ-potential contribution is a minimum and nearly cancels the familiar one-plus-two nucleon-pair contribution to the potential. The corrections to the previously obtained single-pion, η-, ρ-, and ω-meson and two-pion potentials are such as to increase the resemblance to Hamada-Johnston and Reid potentials or increase the resemblance to the Feshbach-Lomon potential for σ-meson widths near 620 and 660 MeV, respectively. (auth)

29308 PRONG DISTRIBUTION IN pp INELASTIC COLLISIONS UP TO 70 GeV. Chow, G. Y. (Saginaw Valley Coll., Mich.). Phys. Rev., D; 5: No. 5, 1219-22(1 Mar 1972).

The calculation by Chow and Rix and by Chow of multiplicity distributions of charged particles in pp inelastic collisions has been extended to cover lab energies up to 700 GeV. The basic assumption is a Poisson distribution in the number of produced pions constrained by isospin independence. The calculation is compared with various models and new experimental data. (auth)

29309 COMMENT ON A MODEL FOR RESONANCE PRODUCTION. Fishbane, Paul M.; Trefil, J. S. (Univ. of Virginia, Charlottesville). Phys. Rev., D; 5: No. 5, 1222-4(1 Mar 1972).

The effect of a model recently proposed by Elitzur for resonance production on the total nucleon-nucleus cross section at high energy is calculated. (auth)

29310 MULTIPLE-SCATTERING THEORY FOR PION-NUCLEUS SCATTERING NEAR THE 3,3 RESONANCE. Charlton, Lowell Arthur. Charlottesville, Va.; Univ. of Virginia (1971). 130p. University Microfilms Order No. 72-7199.

Thesis.

Multiple-scattering theory is used to calculate the differential and total cross sections for the elastic scattering of pions on closed-shell nuclei in the energy range near the 3,3 resonance. Results are presented for ^4He and ^{16}O. A separable form for the fundamental pion-nucleon interaction is used which allows a comparison of several of the standard approximation techniques. One of these is the coherent approximation whereby the nucleus is assumed to remain in its ground state between internal scatterings. In this approximation, terms corresponding to one through four scatterings of the pion on the constituent nucleons are evaluated individually in the case of ^4He. The first two of these terms are calculated for ^{16}O. A summed result is obtained for both nuclei. The closure approximation, which allows all nuclear excited states to enter between the internal scatterings, is used to calculate single and double scattering terms. This formalism allows insertion of realistic nucleon-nucleon correlations also. A third technique is the on-shell approximation where, in addition to the coherent approximation, the pion is assumed to remain always on-shell. This additional assumption allows an investigation of the convergence properties of the multiple-scattering expansion. Also, studies are made of the effect of a correct center-of-mass motion treatment and of inclusion of the pion absorption with two nucleon emission processes. It is found that the multiple-scattering expansion may not converge near the 3,3 resonance for all but the lightest of nuclei, so that an approach is necessary—such as that used—which allows for an approximate summation of the series. (Diss. Abstr. Int., B)

29311 PARAMETER-FREE REGGEIZED ABSORPTION MODEL FOR $\Delta(1236)$ PRODUCTION IN PROTON-PROTON REACTIONS. Adjei, S. A. (Imperial Coll. of Science and Tech., London); Collins, P. A.; Hartley, B. J.; Moriarty, K. J. M.; Moore, R. W. Nucl. Phys.; B39: No. 1, 201-15(1972).

A Reggeized absorption model containing no free parameters to be fitted by the data under consideration is applied to single and double $\Delta(1236)$ production in proton-proton reactions in the energy range 5 to 24 GeV/c. Extremely favorable agreement is obtained between the theoretical predictions and the experimental data on differential cross sections and density matrix elements. (auth)

29312 GLAUBER THEORY INTERPRETATION OF PROTON-DEUTERON SCATTERING DATA AT 24.0 GeV/c. Kofoed-Hansen, O. (CERN, Geneva). Nucl. Phys.; B39: No. 1, 61-76(1972).

The momentum-loss spectra of near forward scattered protons on deuterons measured by Amaldi et al. have been interpreted using an improved version of the multiple scattering theory presented previously. All qualitative features of the spectra are reproduced over a range of 9 decades in the double differential cross section. The conclusion of Amaldi et al. that the p-p and p-n differential elastic cross sections are very similar is supported. An indication is found for a difference in the hadronic production cross section, the p-n cross section being roughly only 60% of the p-p cross section for the invariant mass squared range $1.0 < M^{*2} < 2.0$ $(GeV)^2$ and for the four-momentum transfer squared range $1.4 < q^2 < 6(GeV/c)^2$. (auth)

29313 PRODUCTION AND DECAY OF TWO INTERFERING MESON RESONANCES ON NUCLEI. Noble, D. G. (Glasgow Univ.). Nucl. Phys.; B39: No. 1, 489-92(1972).

A formalism is developed to describe the resonance mass distribution of the differential cross sections for the reaction $\pi A \rightarrow$ "M"$A \rightarrow fA$ via multiple scattering within a nucleus of A nucleons resulting in the production of a double resonance system "M" subsequently decaying into a final state f. The t dependence of this mass distribution is described for the specific case of the meson system consisting of a normal two-quark state interacting with an "exotic" four-quark state. (auth)

29314 RELATIVISTIC ONE-BOSON-EXCHANGE MODEL OF NUCLEON–NUCLEON INTERACTION. Schierholz, G. (Univ., Hamburg). Nucl. Phys.; B40: 335-48(1972).

A relativistic one-boson-exchange model due to the exchange of the π, η, ϵ, ρ and ω mesons and an effective σ is presented for the elastic nucleon–nucleon (NN) interaction. The model is based on relativistic quantum mechanics as formulated by Foldy, Fong and Sucher, Coester and others. The potential is calculated from the off-shell field theoretical Born terms corresponding to the forementioned mesons. In order to avoid divergences form factors are introduced. For the vector-meson exchanges they are assumed to have Regge asymptotic behavior. The fictitious σ is fitted to the uncorrelated $\pi\pi$ S-wave contribution calculated by Durso which is to a great extent given by diagrams with an intermediate isobar. The remaining coupling constants are adjusted to the NN phase shifts and to the binding energy of the deuteron. The model fits the phase shifts fairly well and accounts for the deuteron parameters. The obtained coupling constants are compared to the values found by other investigations. (auth)

29315 UNITARITY SYMMETRY CONSTRAINTS ON AN INCLUSIVE REACTION. Curiale, J. S. (Univ. of Nijmegen, Netherlands). Lett. Nuovo Cim.; 3: No. 12, 507-10(18 Mar 1972).

Inequalities relating the inclusive reactions $p + p \rightarrow c +$ anything, where c is a member of an octet in the SU(3) scheme, are derived with the assumption of SU(3) invariance of hadronic physics by using the reduction formula and the Wigner–Eckart theorem. (L.B.S.)

29316 STUDY OF $NN \rightarrow \Delta N$ AND ITS LINE-REVERSED REACTION. Alexander, G.; Frieman, A.; Gotsman, E. (Tel-Aviv Univ., Israel). Nucl. Phys.; B40: 1-12(1972).

Experimental data on the lined reversed reactions $pp \rightarrow \Delta^{++}n$ and $\bar{p}n \rightarrow \bar{\Delta}^{--}p$ are summarized. An attempt is made to understand the unusually large difference between $\sigma(pp \rightarrow \Delta n)$ and $\sigma(\bar{p}n \rightarrow \bar{\Delta}p)$ in terms of the breaking of exchange degeneracy and complex Regge poles. (auth)

29317 SPECULATIONS ON INDIRECT SEARCHES FOR MAGNETIC MONOPOLES. Newmeyer, J. L.; Trefil, J. S. (Univ. of Virginia, Charlottesville). Nuovo Cim.; 8A: No. 4, 703-21(21 Apr 1972).

The superstrong interaction between magnetic monopoles suppresses the production rate of free monopoles and antimonopoles below what one would expect on the basis of standard production models, since, even when a monopole and an antimonopole are created, it is very likely they will be drawn together and annihilate rather than escape each other. This makes it very difficult to search for them directly. Speculations are made on the feasibility of various techniques which could be used to infer the existence of monopoles indirectly. In particular, it may sometimes be possible to recognize a monopole-antimonopole annihilation by its products, which for these purposes is taken to be showers of photons. Conclusions as to the appropriateness of various methods as a function of monopole mass and (magnetic) charge are summarized; the indirect methods are expected to be suited to look for monopoles of high magnetic charge. (auth)

29318 METHOD TO DETERMINE THE TOTAL Δ–NUCLEON CROSS SECTION. Menessier, G.; Nachtmann, O. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B40: 283-8(1972).

It is shown how one could estimate the total Δ resonance-nucleon cross section by analyzing the final state of weak or electromagnetic Δ-production on nuclei. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 29371 and 29840.

29319 CLASS OF NONLINEAR REALIZATIONS OF THE POINCARE GROUP. Dresden, M. (State Univ. of New York, Stony Brook); Albano, A. Contract AT(30-1)-3668B. J. Math. Phys. (N. Y.); 13: No. 3, 275-82(Mar 1972).

A class of nonlinear space-time transformations is exhibited, which forms a nonlinear realization of the Poincaré group. The transformations leave the expression $I = x^2 + f(x^\mu/x^0)$ invariant; f is an arbitrary function of the ratios x^μ/x^0. The infinitesimal generators are constructed as differential operators in the Minkowski space. The transformations are defined only in a restricted region U (the allowed region) of the Minkowski space. By introducing auxiliary variables, the transformations can be recast in their usual linear form; this, however, is in general possible only in a region L (the linear region) which is different from U. The region structure is analyzed in general and given explicitly for a special form of the function f. Among the physical ideas suggested by the nonlinear formalism is the notion of "relativity of coincidence." This expresses the fact that events coincident (or having arbitrary small Minkowski separation) in one frame of reference will not be coincident (or will have finite Minkowski separation) in a transformed frame. (auth)

29320 PROJECTIVE REPRESENTATIONS AND THE RELATION OF INTERNAL TO SPACE–TIME SYMMETRIES. Warren, Russell E.; Klink, William H. (Univ. of Iowa, Iowa City). J. Math. Phys. (N. Y.); 13: No. 3, 306-12(Mar 1972).

The relation of space-time to internal symmetries in relativistic quantum mechanics is investigated using the Mackey theory of induced projective representations of group extensions. Representation multipliers are found for semidirect products of the Poincaré group and arbitrary internal symmetry groups. Upon investigating a typical example, it is found that when relations such as $U_\pi U_C = (-1)^J U_C U_\pi$, obtained from field theory, are assumed, a unique choice of representation multiplier follows; in particular, this multiplier requires $U^2_{C\pi} = 1$ for all J. Representations relative to this multiplier are computed. (auth)

29321 POSITION OPERATORS AS INTERNAL SYMMETRIES. Warren, Russell E.; Klink, William H. (Univ. of Iowa, Iowa City). J. Math. Phys. (N. Y.); 13: No. 3, 312-16(Mar 1972).

Space-time variables are generated as representation labels of an underlying group, the group itself being combined with the Poincaré group in a manner reminiscent of the way in which internal symmetries are combined with the Poincaré group. After representations of the group are found, a transform is introduced which allows one to pass from spinor to Wigner wavefunctions in a boost independent manner, exhibiting clearly the spin dependence of the wavefunctions. (auth)

29322 CONSTANTS OF MOTION AND LIE GROUP ACTIONS. Andrie, M. (Univ., Bonn); Simms, D. J. J. Math. Phys. (N. Y.); 13: No. 3, 331-6(Mar 1972).

A classical Hamiltonian dynamical system with 2N-dimensional phase space is studied in the case when a Lie algebra of constants of the motion exists which contains $2N - 1$ functionally independent elements and when each constant of motion generates a complete integral curve. It is proved that a connected (global) Lie group G acts on the phase space and acts transitively on each connected component of each surface of constant energy. When G is compact, each component of the space of time orbits corresponding to a fixed energy is shown to be a $(2N - 2)$-dimensional compact symplectic manifold diffeomorphic to an orbit of G in the dual of the adjoint representation. It is shown that a (global) Lie group does act in the case of the harmonic oscillator, but does not act in the case of the negative energy Kepler problem. (auth)

29323 PROJECTIVE UNITARY ANTIUNITARY REPRESENTATIONS OF FINITE GROUPS. Janssen, T. (Katholieke Univ., Nijmegen, Netherlands). J. Math. Phys. (N. Y.); 13: No. 3, 342-51(Mar 1972).

A generalization of Schur's treatment of projective representations is discussed for a very general class of representations occurring in physical theories: the projective representations by unitary and antiunitary operators. It is shown that for every finite group the projective unitary-antiunitary (PUA) representations can be obtained from the ordinary unitary-antiunitary representations of another finite group. The construction of such a representation group is treated. As an example the theory is applied for the determination of irreducible representations of subgroups of the Poincaré group. The classes of PUA representations for all finite crystallographic groups in spaces of dimension up to four are explicitly given. (auth)

29324 COMMUTING POLYNOMIALS IN QUANTUM CANONICAL OPERATORS AND REALIZATIONS OF LIE ALGEBRAS. Joseph, A. (Tel-Aviv Univ., Ramat-Aviv, Israel). J. Math. Phys. (N. Y.); 13: No. 3, 351-7(Mar 1972).

It is pointed out that the problem of realizing Lie algebras through polynomials in quantum canonical operators is not equivalent to its classical counterpart because the polynomial Lie algebras taken with respect to the classical and quantum Lie brackets are not isomorphic. Yet there are still many results which are common to both. To show this, the properties of commuting polynomials in quantum canonical operators are analyzed. This makes possible an extension from the classical to the quantum domain of a number of theorems on realizations of semisimple Lie algebras. At the same time it is stressed that differences can arise in the classical and quantum solutions, and some of these are described. (auth)

29325 REPRESENTATIONS OF THE LOCAL CURRENT ALGEBRA: A CONSTRUCTIONAL APPROACH. Mendes,

Rui V. (Univ. of Texas, Austin); Ne'eman, Yuval. Springer Tracts Mod. Phys.; 60: 18-31(1971).

A lecture is given on the study of the Dashen–Gell-Mann hypothesis that the equal-time commutators defining the local algebra of charge densities are saturated by one-particle states in the infinite-momentum limit. The approach is to study representations of the algebra of currents without any kinematical constraints on the states and operators, leaving the transformation properties under the operations of the Poincare group to be implemented later by a constructure procedure. (J.F.P.)

29326 LOCAL PROPERTIES OF σ-TERMS: A REVIEW. Genz, H. (Univ., Karlsruhe, Ger.). Springer Tracts Mod. Phys.; 61: 130-6(1972).

Properties of Schwinger terms contained in the equal-time commutators of the SU(3) ⊗ SU(3) charge densities with the SU(3) ⊗ SU(3) current divergences are reviewed. (auth)

29327 SLICED EXTENSIONS, IRREDUCIBLE EXTENSIONS, AND ASSOCIATED GRAPHS: AN ANALYSIS OF LIE ALGEBRA EXTENSIONS. I. GENERAL THEORY. Cattaneo, U. (Univ. Catholique, Louvain, Belg. Katholieke Univ., Nijmegen, Netherlands). J. Math. Phys. (N. Y.); 13: No. 4, 504-18(Apr 1972).

The Lie algebra extension problem is investigated and incorporated into a formalism which allows for a visualization of the algebraic structures involved. A finer analysis than the usual mathematical one is sometimes required for the physical applications. This brings about the consideration of sliced extensions, i.e., of extensions provided with sections. Some of these, the ω-sliced extensions, are particularly interesting. They are directly connected with natural Levi decompositions of the Lie algebras obtained from extensions. Graphs are associated with ω-sliced extensions. This is especially suitable for the study of irreducible extensions, which are the basic ones among the extensions. Their structure may be described in terms of graph theory. A subset is picked out from the set of all irreducible extensions of an arbitrary Lie algebra. Its elements, the primitive extensions, have the simplest extension structure and are characterized by the empty graph or by one-vertex graphs. (auth)

29328 SLICED EXTENSIONS, IRREDUCIBLE EXTENSIONS, AND ASSOCIATED GRAPHS: AN ANALYSIS OF LIE ALGEBRA EXTENSIONS. II. APPLICATION TO EUCLIDEAN, POINCARE, AND GALILEAN ALGEBRAS. Cattaneo, U. (Katholieke Univ., Nijmegen, Netherlands). J. Math. Phys. (N. Y.); 13: No. 4, 518-28(Apr 1972).

The results of preceding work on Lie algebra extensions and sliced extensions are applied to the Lie algebras E(3), P, and G of the Euclidean, resp. Poincaré and Galilean groups. The primitive extensions are analyzed in detail. A procedure for the construction of irreducible extensions is illustrated by some examples, using diagrams which picture the graphs of the extensions. It is proved that all extensions by E(3), P, and G are inessential. (auth)

29329 GENERALIZATION OF EULER ANGLES TO N-DIMENSIONAL ORTHOGONAL MATRICES. Hoffman, David K.; Raffenetti, Richard C.; Ruedenberg, Klaus (Ames Lab., Iowa). J. Math. Phys. (N. Y.); 13: No. 4, 528-33(Apr 1972).

An algorithm is presented whereby an N-dimensional orthogonal matrix can be represented in terms of $\frac{1}{2}$ N(N − 1) independent parameters $\theta_k^{(\nu)}[\nu = 2,3, \ldots, N; k = 1,2, \ldots, (\nu - 1)]$. The parameters have the character of angles, whose compact domains are defined in a manner such that there exists a one-to-one correspondence between the points in the parameter space and the group of orthogonal matrices. Explicit formulas are given which express all matrix elements in terms of the angles, and formulas are given which express the angles in terms of the matrix elements. Special choices of angles give block-diagonal matrices. For three-dimensional matrices, the parametrization is equivalent to that of Euler. (auth)

29330 INTERNAL LABELING AND THE GROUP G_2. Wybourne, B. G. (Univ. of Canterbury, Christchurch, New Zealand). J. Math. Phys. (N. Y.); 13: No. 4, 455-7(Apr 1972).

The states associated with the group-subgroup $R_7 \supset G_2$ are unambiguously representable as the stretched product states of just seven elementary multiplets. This result is used to derive a number of branching rules for the decomposition $R_7 \rightarrow G_2$ in a simpler manner than hitherto available. An example of the decomposition of the spin representations of R_7 is given. (auth)

29331 GEODESICS AND CLASSICAL MECHANICS ON LIE GROUPS. Hermann, Robert (Rutgers-The State Univ., New Brunswick, N. J.). J. Math. Phys. (N. Y.); 13: No. 4, 460-4 (Apr 1972).

Hamilton–Jacobi Theory on Lie groups is discussed, and an error in a previous paper is corrected. A method for "analytically continuing" geodesics from compact to noncompact Lie groups is presented. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstract 29245.

29332 LIMIT ON NUCLEAR TIME-REVERSAL-INVARIANCE VIOLATION FROM THE NEUTRON ELECTRIC DIPOLE MOMENT. Broadhurst, D. J. (Stanford Univ., Calif.). Phys. Rev., D; 5: No. 5, 1228-30(1 Mar 1972).

Time-reversal noninvariance in nuclei has recently been parametrized in terms of a four-point coupling, of undetermined strength, of an isovector photon, a charged pion, and the nucleon current. If parity violation is introduced via the weak interaction, this coupling is restricted by the failure to observe a neutron electric dipole moment to a size which is an order of magnitude smaller than the limit imposed by present nuclear γ-decay experiments. (auth)

29333 POLARIZATION OF THE RECOIL PROTON FOR PROTON COMPTON SCATTERING BELOW THE PION PRODUCTION THRESHOLD. Fengler, H. (Technische Hochschule, Darmstadt, Ger.). Z. Naturforsch.; 27a: No. 3, 488-90(Mar 1972).

The polarization of the recoil proton for Compton scattering on protons below the pion production threshold, which arises from fourth-order Feynman diagrams, is calculated by using the second-order Compton amplitude in the unitary condition. It is assumed that the second-order amplitude can be approximated by the one-proton intermediate-state contribution. The polarization does not exceed 0.1% in the entire range of the scattering angle. (auth)

29334 VERIFICATION OF CPT-INVARIANCE IN EXPERIMENTS WITH K^0 MESONS. Margvelashvili, P. I. (Tbilisi State Univ., USSR). JETP Lett. (USSR) (Engl. Transl.); 10: No. 9, 290-1(5 Nov 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 10: No. 9, 450-3(5 Nov 1969).

On the basis of the unitarity condition for unstable particles, a relation is derived that holds in the case of CPT invariance and does not contain the parameter ϕ_{00}. The decays $K_1^0 \rightarrow \pi^0(\pi^+) + \pi^0(\pi^-)$ are considered. It is noted that the experimental data on the parameters η_{00}, δ_1 and x should be refined. (J.F.P.)

29335 NEW HIGH-ENERGY SCALE. Lee, T. D. (Columbia Univ., New York). Phys. Today; 25: No. 4, 23-8(Apr 1972).

A review of the scaling hypothesis is given. Applications of the hypothesis, the breakdown of scaling, limits of the Fermi theory, divergence difficulties, the indefinite metric, results for weak interactions, and a possible new energy scale are discussed. (J.F.P.)

Applications (Strong)

29336 CHIRAL SYMMETRY: AN APPROACH TO THE STUDY OF THE STRONG INTERACTIONS. Weinstein, M. (New York Univ., N. Y.). Springer Tracts Mod. Phys.; 60: 32-73(1971).

Lectures are given on the general structure of strong interactions as determined from the joint assumptions of PCAC theory and current algebra. The Goldberger–Treiman relation, the conversional and Goldstone basic assumptions for symmetries, phenomenological Lagrangians, beyond the zeroth approximation, and SU(3) × SU(3) and weak and electromagnetic processes are treated. (J.F.P.)

Field Theories

General

Refer also to abstract 30144.

29337 MELLIN-TRANSFORMATION METHOD FOR NON-POLYNOMIAL INTERACTIONS. Houard, J. C.; Irac-Astaud, M. (College de France, Paris). Nuovo Cim.; 8B: No. 2, 461-77(11 Apr 1972).

The x- and p-space methods for nonpolynomial interactions are studied and compared. Although the common purpose of these methods is to assign a finite value to the divergent series representing the amplitudes, it appears that the expressions resulting from the p-space method are generally infinite, and therefore have to be carefully revised. For that purpose the x-space formula is cast in a new form similar to the p-space one. Arbitrariness is investigated, and unitarity is checked. (auth)

29338 NEW UNIFIED FIELD THEORY OF THE UNIVERSE AND ATOM. Chakravorty, K. R. Technology (Sindri); 7: No. 3A, 3-78(1970).

The topics discussed are the new unified field theory, the nature of unified continuum, the nature of transition through critical states, the thermodynamic phase and numerical continua, number and decimal continua, four-dimensional tetrahedral evolution represented as continuum of squares in a plane, and criteria for development of square and numerical continua. Also multidimensional configurations, the square continuum and quantum phenomena with algebraic representation, the square continuum and electronic development of atomic structure, and the nature of the energy-matter relation are considered. (J.F.P.)

Quantum Field Theory

Refer also to abstracts 29130, 29143, 29222, 29319, and 29320.

29339 (DESY-72/6) CALCULATIONS IN CONFORMAL INVARIANT FIELD THEORIES. Symanzik, K. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Feb 1972. 11p. Dep. NTIS (U. S. Sales Only).

A formula allowing manifestly conformal covariant calculations to be performed in Polyakov-Migdal conformal invariant theories is derived, and its uses are discussed. (auth)

29340 (LA-4831) SELF-CONSISTENT BILOCAL FIELD THEORY. Rich, Marvin (Los Alamos Scientific Lab., N. Mex.). Mar 1972. Contract W-7405-eng-36. 39p. Dep. NTIS.

A nonrelativistic formulation of quantum field theory is outlined in which the field operators are assumed to depend on a pair of spatial positions so as to describe extended particles with internal as well as center of mass motion. The perturbation expansion of the S-matrix is obtained in the interaction picture for a simplified version of the theory in which the fermion fields are bilocal and the boson fields are local. Comparison of corresponding self-energy matrix elements of the bilocal and local theory indicates that, while the local result is definitely divergent, the bilocal term is likely finite. Within the bilocal framework, a self-consistent equation is derived for the internal fermion motion in terms of a dynamical potential calculated from the fermion self-energy diagrams. Examples of this equation are given for scalar, pseudoscalar, and vector meson interactions using the lowest order dynamical potential. Relativistic extensions of this theory are discussed, and some applications which might serve as tests of its validity are considered. (auth)

29341 HADRONIC CORRECTIONS TO GOLDBERGER-TREIMAN RELATIONS FOR STRANGENESS-CARRYING CURRENTS. Chen, J. (Univ. of Rochester, N. Y.). Phys. Rev., D; 5: No. 5, 1143-9(1 Mar 1972).

Hadronic corrections to Goldberger-Treiman relations for vector and axial-vector strangeness-carrying currents are calculated. In both cases, the corrections are found to be less than 10%. A bound for $G_{\Delta pK}$ is set. (auth)

29342 VELOCITY OF EXCITATION TRANSFER IN AN ACCURATELY RESOLVED MODEL OF QUANTUM ELECTRODYNAMICS. Eganova, I. A. (Inst. of Physics, Baku). Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk; No. 1, 94-109(1971). (In Russian).

A model consisting of two nonrelativistic electrons in oscillator cavities, and interacting with a quantized electromagnetic field, was used in a quantum electrodynamical study of the amplitude of transmission of excitation. One proposition deals with a vector two-point function as a model operator of the electromagnetic field. (K.S.W.)

29343 SOME OPERATOR GRADIENT TRANSFORMATION. Jancewicz, B. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci., Math., Astron. Phys.; 20: No. 1, 79-84(1972).

A group of operator gradient transformations for electromagnetic potential of the free quantum field is found. The transformed field is covariant under the same unitary representation of the Poincaré group. The transformations are unitarily implemented and act identically on physical states. (auth)

29344 SPONTANEOUS BREAKDOWN OF THE γ_5 INVARIANCE. Hosek, J. (Nuclear Research Inst., Rez, Czech.). Nucl. Phys.; B39: No. 1, 407-12(1972).

The invariance properties of the free fermion Lagrangian with respect to the Touschek transformation are treated. It is shown that the introduction of two scalar fields guarantees this invariance. An indication is given according to which these scalar fields are interpreted as responsible for the spontaneous breakdown of the symmetry. As a result only one scalar particle and one massive pseudovector boson are obtained. (auth)

29345 NUMERICAL STUDY OF ANALYTICITY IN THE COUPLING CONSTANT. Ruijgrok, Th. W. (CERN, Geneva). Nucl. Phys.; B39: No. 1, 616-42(1972).

For two simple field theories, both of zero-space dimension, the Riemann surface of the energy as a function of the square of the coupling constant is studied. The convergence of perturbation theory is established and a comparison is made between the exact energies and their Padé approximations. (auth)

29346 NOTE ON SCHWINGER'S ACTION PRINCIPLE. Manoukian, E. B. (Univ. of Alberta, Edmonton). Lett. Nuovo Cim.; 3: No. 12, 526-8(18 Mar 1972).

A rigorous proof is given of the existence of Schwinger's action principle in s-dimensions of space with $s > 4$. The proof applies to bounded-interaction Hamiltonians in nonlocal field theories of pure Fermi interactions without pure creation terms and in potential scattering. (L.B.S.)

29347 CAUSALITY AND DUALITY. Rivers, R. J. (Imperial Coll. of Science and Tech., London). Nucl. Phys.; B40: 269-82 (1972).

The causality and convergence of the dual perturbation series are discussed by analogy with nonlocal nonpolynomial field theory. (auth)

29348 μ-MESIC HYDROGEN AND $(g-2)$ OF THE MUON AS POSSIBLE TESTS OF THE ELECTRON PROPAGATOR. Magg, M.; Ringhofer, K.; Salecker, H. (Univ., Munich). Nucl. Phys.; B40: 367-74(1972).

Since gauge invariant modifications of the electron propagator do not contribute to scattering experiments, the Lamb shift of the μ-mesic hydrogen and the $(g-2)$ of the muon are investigated. Using a modified electron propagator $S = 1/(\not{p}-m_e) + f/(\not{p}-M)$ where m_e is the mass of the electron, it is found that for $f = 1$ the length M^{-1} has to be smaller than $\frac{1}{100}\, m_e^{-1} \approx 0.4 \times 10^{-12}$ cm. It is concluded that even in the case of gauge-invariant modifications of quantum electrodynamics the electron propagator can be tested quite accurately. (auth)

29349 ANALYTIC VERTEX EXPANSION IN QUANTUM ELECTRODYNAMICS. Saller, H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nucl. Phys.; B40: 65-76 (1972).

A definition of finite operator products is tested in quantum electrodynamics—achieved by an analytic expansion of nonlocalities in momentum space. The conditions of gauge invariance and renormalization determine uniquely those functions which render the operator product nonlocal before the final limiting process. (auth)

29350 REGGE SLOPES AND THE SCHIZOPHRENIC POMERON IN THE ABFST MODEL. Dash, J. (Cambridge Univ., Eng.). Nuovo Cim.; 8A: No. 4, 787-800(21 Apr 1972).

Approximate but analytic solutions to the ABFST equation are obtained both for the resonance and AFS kernels. Explicit formulas for the slopes of Regge trajectories at $t = 0$ are obtained. The resonance kernel alone produces normal values for the slope ($\alpha' \approx 0.8$ (GeV)$^{-2}$) for $\alpha_0 = 0.5$ to 0.8, while a bootstrap with the AFS kernel composed of two pomerons with intercept 0.97 yields $\alpha' \approx$ (0.1 to 0.4) (GeV)$^{-2}$. (auth)

29351 SUMMABILITY METHODS, THE STRONG ASYMPTOTIC CONDITION, AND UNITARITY IN QUANTUM FIELD THEORY. Simon, Barry (Princeton Univ., N. J.). Phys. Rev. Lett.; 28: No. 17, 1145-6(24 Apr 1972).

A summability mechanism is discussed which preserves nonlinear perturbative conditions such as unitarity of the Feynman series. This condition, which relates a function f(z) and a series $\Sigma\, a_n z^n$ by the requirement $|f(z) - \Sigma_{n=0}^{N} a_n z^n| \leq A\sigma^{N+1}(N+1)!\,|z|^{N+1}$, is applicable to certain divergent series. (auth)

29352 QUASI-STATISTICAL CASE OF THE PERTURBATION THEORY FOR TWO CLOSE LEVELS WITH VARIABLE PERIODICAL PERTURBATION. Lalov, Iv. God., Sofii Univ., Fiz. Fak.; 62: 75-88(1967-1968). (In Bulgarian).

An examination is made of a quantum system in which two levels in an unperturbed state have close energies, while the other levels of the system have an energy strongly differing from them. The behavior of the system with the application of variable periodical perturbation is considered in the approximation of the so-called quasi-statistical case of the perturbation theory. A special study was made of the cases of perturbation of a rectangular, impulse, or sine form and of the case of low perturbation. (auth)

29353 NONPOLYNOMIAL LAGRANGIANS WITH ISOSPIN. Delbourgo, R. (Imperial Coll. of Science and Tech., London). J. Math. Phys. (N. Y.); 13: No. 4, 464-8(Apr 1972).

The (Laplace, Fourier, ...) transform methods are applied to obtain compact representations of the perturbation S-matrix elements for interaction Lagrangians which are general nonpolynomial functions of isospin multiplets. In order to illustrate the power and simplicity of the method for coping with the isospin complications, several examples are treated in detail, and these

include the commonly used parametrizations of the unitary chiral SU(2) ⊗ SU(2) transformations. (auth)

29354 SPECTRUM OF LOCAL HAMILTONIANS IN THE YUKAWA$_2$ FIELD THEORY. Dimock, Jonathan (Harvard Univ., Cambridge, Mass.). J. Math. Phys. (N. Y.); 13: No. 4, 477-81 (Apr 1972).

It is proved that the local Hamiltonians constructed for the two-dimensional Yukawa model by Glimm and Jaffe have the same continuous spectrum as the free Hamiltonian. The proof depends on the construction of asymptotic creation and annihilation operators. (auth)

Gravitation and General Relativity

Refer also to abstract 28987.

29355 (RLO-1388-621) INCONSISTENCY OF FINITE RANGE GRAVITATION. Boulware, David G. (Washington Univ., Seattle. Dept. of Physics); Deser, S. (Brandeis Univ., Waltham, Mass. Dept. of Physics. Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). [nd]. Contract AT(45-1)-1388. 10p. Dep. NTIS.

Gravitational theories with arbitrarily large but finite range either violate basic physical requirements, do not limit to general relativity, or both. (auth)

29356 EMPIRICAL TEST OF EINSTEIN'S UNIFIED FIELD THEORY. Johnson, C. R. (Univ. of Georgia, Athens). Nuovo Cim.; 8B: No. 2, 391-8(11 Apr 1972).

An outline of an analysis of Einstein's theory of the non-symmetric field is presented showing that there are particles in the theory which interact in lowest approximation through the conventional classical electromagnetic interaction. Also associated with these particles is a weak nonconventional electromagnetic interaction important only over astronomical distances. The form of this nonconventional electromagnetic interaction is examined, and based on this examination a possible empirical test of Einstein's theory is described. (auth)

29357 ROLE OF CONFORMAL THREE-GEOMETRY IN THE DYNAMICS OF GRAVITATION. York, James W. Jr. (Princeton Univ., N. J.). Phys. Rev. Lett.; 28: No. 16, 1082-5(17 Apr 1972).

The unconstrained dynamical degrees of freedom of the gravitational field are identified with the conformally invariant three-geometries of spacelike hypersurfaces. New results concerning the action principle, choice of canonical variables, and initial-value equations strengthen this identification. One of the new canonical variables is shown to play the role of "time" in the formalism. (auth)

29358 NEWTONIAN GRAVITATIONAL FIELD THEORY. Synge, J. L. (Dublin Inst. for Advanced Studies). Nuovo Cim.; 8B: No. 2, 373-90(11 Apr 1972).

The discussion concerns only Newtonian gravitation and aims at clarifying the concept of energy in this context. Use is made of gravitational energy density, suggested by Maxwell, but not acceptable to him since it is negative. (auth)

29359 SPECIAL CURVES IN THE AUTHOR'S RESTRICTED EINSTEIN UNIFIED FIELD THEORY. Nix, E. D. Tensor; 23: No. 1, 97-104(Jan 1972).

Time-like curves of a vanishing electromagnetic field are used in conjectured boundary conditions as if they were idealized observers centers of sensory awareness. The mathematics involved is conjectural and depends on the problems in analysis of the nonabsolutely compatible restricted field equations. (J.F.P.)

29360 RELATIONSHIP BETWEEN THE CLASSIFICATION OF EINSTEIN SPACE-TIMES WITH RESPECT TO THE RANKS OF THE MATRIX OF THE CURVATURE TENSOR AND THE CLASSIFICATION OF PETROV. Jakubowicz, Antoni (Technical Univ., Szczecin, Poland). Tensor; 23: No. 1, 91-4(Jan 1972).

A classification was given previously for the four-dimensional Einstein space-times G_4^1 with the signature (+---) with respect to the invariants r_M, r_R, r_R^1 and r_F. The relation between the classification of the spaces G_4^1 and the classification of Petrov is given. (J.F.P.)

29361 ENNUPLE VECTORS IN CONFORMALLY FLAT SPACES. Tupper, B. O. J. (Univ. of New Brunswick, Fredericton). Tensor; 23: No. 1, 51-6(Jan 1972).

Conformally flat space-times which satisfy the generalized field equations and some of the properties of the ennuples associated with them are discussed. The corresponding results for a general conformally flat V_n are also found. (J.F.P.)

29362 FOCUSSING OF ELECTRICAL CHARGE-FREE PARTICLES. Szpilecki, Jozef. Postepy Fiz.; 23: No. 1, 47-61(1972). (In Polish).

Three methods of focusing are discussed: the inhomogeneous magnetic field method (Stern-Gerlach experiment, hexapole lens); the Maier-Leibnitz gravitational field method; and the method of inertial forces (centrifugal and Coriolis). (auth)

29363 COLLIDING PLANE GRAVITATIONAL WAVES. Szekeres, P. (Univ. of Adelaide). J. Math. Phys. (N. Y.); 13: No. 3, 286-94(Mar 1972).

The equations governing the collision of two plane gravitational waves are derived. The general exact solution representing this situation when both waves are linearly polarized is found, and some special solutions of possible physical interest are discussed in detail. (auth)

29364 METHOD FOR GENERATING NEW SOLUTIONS OF EINSTEIN'S EQUATION. II. Geroch, Robert (Univ. of Texas, Austin). J. Math. Phys. (N. Y.); 13: No. 3, 394-404(Mar 1972).

A scheme is introduced which yields, beginning with any source-free solution of Einstein's equation with two commuting Killing fields for which a certain pair of constants vanish (e.g., the exterior field of a rotating star), a family of new exact solutions. To obtain a new solution, one must specify an arbitrary curve (up to parametrization) in a certain three-dimensional vector space. Thus, a single solution of Einstein's equation generates a family of new solutions involving two arbitrary functions of one variable. These transformations on exact solutions form a non-Abelian group. The extensive algebraic structure thereby induced on such solutions is studied. (auth)

29365 QUANTIZATION IN A CURVED SPACE-TIME. CREATION AND ANNIHILATION COMMUTATORS AND OPERATORS. Moreno, Carlos (Univ., Paris). Compt. Rend., Ser. A; 274: No. 3, 281-4(17 Jan 1972). (In French).

Using the definitions of the field associated with a solution of the Klein-Gordon equation and the quantum field, a precise interpretation of the field commutation rules and the quantum momentum rules for a scalar particle without charge in a curved space-time is given. (France)

29366 THEORY OF RELATIVITY BASED ON PHYSICAL REALITY. Janossy, L. Budapest; Akademiai Kiado (1971). 317p.

A re-evaluation of the facts which led to the establishment of the special and general theories of relativity is given. A mathematical formalism is obtained which is strictly equivalent to the known formalism of relativity. The topics covered are a survey of some experimental results relating to the propagation of light and connected phenomena, the carrier of electromagnetic waves, measurement, the Lorentz transformation, the Lorentz principle, relativistic mechanics, the electromagnetic field, gravitation theory, and cosmological problems. (J.F.P.)

29367 GENERATING POTENTIAL FOR THE NUT METRIC IN GENERAL RELATIVITY. Gautreau, R. (Newark Coll. of Engineering, N. J.); Hoffman, R. B. Phys. Lett.; 39A: No. 1, 75-6(10 Apr 1972).

It is shown that the Newtonian potential that generates the static Schwarzchild and Reissner-Nordström metrics also generates the NUT space metric from the class of Papapetrou stationary fields. (auth)

29368 UNIVERSAL REGULATOR? Tran Huu Phat (Hanoi Univ., North Viet-Nam). Ann. Phys. (Leipzig); 27: No. 4, 321-35 (1971).

By using the principle of metrical invariance which requires that all physical laws are independent of the choice of units (alternatively, all physical laws are invariant with respect to scale transformations of space-time coordinates) and Goldstone's theorem, a universal regulator is discovered. The cosmic field is the Yang-Mills field of the local scale transformations. Its physical role is as follows. Cosmon, its quantum, is a massless, spinless, and neutral particle. The cosmic field is created by inertial masses. Therefore it participates in all physical processes, and if its presence is taken into account, then the quantum field theory is free from all ultraviolet infinities. From the point of view of Yang-Mills field theory, it is proved that the so-called gravitational masses are identical with inertial masses and the gravitational field is created by inertial masses moving noninertially. This fact permits one to solve satisfactorily the problem of energy-momentum complex of the gravitational field. The system of equations which defines simultaneously the cosmic and gravitational fields is established. A non-Einstein cosmology is outlined. (auth)

29369 GAUGE-DEPENDENT GRAVITATIONAL POTENTIAL. Hiida, K. (Tokyo Univ.); Kimura, T. Lett. Nuovo Cim.; 3: No. 12, 490-4(18 Mar 1972).

The arbitrariness in the form of the gravitation propagator and gravitational potential under an arbitrary q-number gauge transformation for the graviton field. In particular, the following are examined: the general form of the two-body potential obtained by Hiida and Okamura; the effect of a unitary transformation on the Hamiltonian on the gravitational potential or equation of motion; and the gauge dependence of the three-body static potential. (L.B.S.)

29370 RECEPTION OF GRAVITATIONAL RADIATION OF EXTRATERRESTRIAL ORIGIN. Braginskii, V. B.; Zel'dovich, Ya. B.; Rudenko, V. N. (Inst. of Applied Mathematics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 10: No. 9, 280-3(5 Nov 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 10: No. 9, 437-41(5 Nov 1969).

A discussion is given of the Weber experiment on cosmic gravitational radiation. The gravitational wave energy and the power and location of the sources are discussed, and a modulator-type gravitational radiation receiver is described. (J.F.P.)

29371 CONFORMAL INVARIANCE AND THE ENERGY–MOMENTUM TENSOR. Wess, J. (Univ., Karlsruhe, Ger.). Springer Tracts Mod. Phys.; 60: 1-17(1971).

A lecture is given on the energy–momentum tensor covering the conformal group, low-energy theory for gravitons, conformal invariance and effective Lagrangians, and invariant Lagrangian for a scalar field. (J.F.P.)

29372 EXAMPLE OF CREATION OF MATTER BY A GRAVITATIONAL FIELD. Kharpko, R. I. (Moscow Aviation Inst.). Zh. Eksp. Teor. Fiz.; 62: No. 3, 833-5(Mar 1972). (In Russian).

An example of creation of matter in the form of a compact body and of its subsequent annihilation in an external nonstationary gravitational field is developed within the framework of classical general relativity theory without application of quantum theory. (auth)

29373 REMARK ON ENERGY AND MOMENTUM IN EMBEDDED SPACE-TIMES. Buchner, Klaus (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 6, 1946-7(Dec 1971).

The problem is considered that if in Euclidean space a mass moves on some curved surface, there occur forces of constraint, and similar effects are expected to be present in curved space times, are there any connections with the difficulties in the formulation of the conservation law. The momentum density is transformed into the embedding space, and it is shown that the force which causes the nonconservation of this momentum is just the above-mentioned force of constraint. Thus in this respect the embedding leads to a consistent theory. (J.F.P.)

29374 NOTE ON THE ANGULAR MOMENTUM AND MASS OF GRAVITATIONAL GEONS. Cohen, Jeffrey M. (Univ. of Pennsylvania, Philadelphia); Wald, Robert M. J. Math. Phys. (N. Y.); 13: No. 4, 543-5(Apr 1972).

It is shown that the angular momentum of a gravitational geon must be zero if it is axisymmetric and the mass of a gravitational geon must be zero if it is stationary, i.e., if the space-time possesses a Killing vector which is timelike at infinity. Angular momentum and mass are defined in terms of the asymptotic form of the metric at large distances; they are physical quantities which can be experimentally measured by distant observers. Since the gravitational geons previously considered are highly dynamical on a small scale, the result on the vanishing mass of stationary geon does not conflict with previous analyses showing that gravitational geons can have mass. Similarly, the results do not exclude the possibility of gravitational geons having nonvanishing angular momentum if they are not strictly axisymmetric. (auth)

29375 EINSTEIN EQUATIONS OF EVOLUTION: A GEOMETRIC APPROACH. Fischer, Arthur E.; Marsden, Jerrold E. (Univ. of California, Berkeley). J. Math. Phys. (N. Y.); 13: No. 4, 546-68(Apr 1972).

The exterior Einstein equations are explored from a differential geometric point of view. Using methods of global analysis and infinite-dimensional geometry, the question is answered sharply: "In what sense are the Einstein equations, written as equations of evolution, a Lagrangian dynamical system?" By using the global methods, several aspects of the lapse function and shift vector field are clarified. The geometrical significance of the shift becomes apparent when the Einstein evolution equations are written using Lie derivatives. The evolution equations are then interpreted as evolution equations as seen by an observer in space coordinates. Using the notion of body-space transitions, the relation is then found between solutions with different shifts by finding the flow of a time-dependent vector field. The use of body and space coordinates is shown to be somewhat analogous to the use of such coordinates in Euler's equations for a rigid body and the use of Eulerian and Lagrangian coordinates in hydrodynamics. Also the geometry of the lapse function is explored, and it is shown how one can pass from one lapse function to another by integrating ordinary differential equations. This involves integrating what is called the "intrinsic shift vector field." The essence of the method is to extend the usual configuration space $\mathcal{M}$ = Riem (M) of Riemannian metrics to $T \times D \times \mathcal{M}$, where $T = C^{\infty}(M,R)$ is the group of relativistic time translations and D = Diff(M) is the group of spatial coordinate transformations of M. The lapse and shift then enter the dynamical picture naturally as the velocities canonically conjugate to the configuration fields $(\xi_t, \eta_t) \in T \times D$. On this extended configuration space, a degenerate Lagrangian system is constructed which allows precisely for the arbitrary specification of the lapse and shift functions. A metric given by DeWitt for $\mathcal{M}$ is reinterpreted as a degenerate metric on $D \times \mathcal{M}$. On $D \times \mathcal{M}$, however, the metric is quadratic in the velocity variables. The groups T and D also serve as symmetry groups for the dynamical system. It is established that the associated conserved quantities are just the usual "constraint equations." A precise theorem is given for a remark of Misner that in an empty space-time we must have H = 0. The relation between the evolution equations for the time-dependent metric g_t and the Ricci flat condition of the reconstructed Lorentz metric g^L is studied. Finally, some remarks are made about a possible "superphase space" for general relativity and how the treatment on $T \times D \times \mathcal{M}$ is related to ordinary superspace and superphase space. (auth)

Scattering Theory

29376 (IFVE-STF-70-72) SCATTERING ON A SMOOTH POTENTIAL AT HIGH ENERGIES. Mestvirishvili, M. A.; Rcheulishvili, G. L. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov, Institut Fiziki Vysokikh Energii). 1970. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

The scattering amplitude behavior in the high-energy region for a smooth potential $V(r) = V_0(k)[(e^{-\alpha\sqrt{r^2+a^2}})/(\sqrt{r^2+a^2})]$ is studied. (auth)

29377 (IFVE-STF-71-8) HIGH-ENERGY BEHAVIOR OF FORWARD SCATTERING AMPLITUDE. Volkov, G. G. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov, Institut Fiziki Vysokikh Energii). 1971. 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

The asymptotic behavior of the forward scattering amplitude is connected with the properties of the conformal reflection given by the amplitude. Consequences, imposed on the total cross section by various assumptions on the behavior of the amplitude phase and on the distribution of the signs of the real part in the physical region, in particular, are studied. (auth)

29378 (IFVE-STF-71-24) ESTIMATION OF QUASI-POTENTIAL PHASE OF SCATTERING.' Arkhipov, A. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov, Institut Fiziki Vysokikh Energii). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The quasipotential phase of scattering was calculated in first and second orders over quasipotential. (auth)

29379 EIKONAL APPROXIMATION AND EXACTLY SOLVABLE MODELS. Aly, H. H. (Southern Illinois Univ., Edwardsville); Mahajan, Sukhbin. Particles Nucl.; 3: No. 2, 65-8(Feb 1972).

Two exactly solvable potential models corresponding to two model field theories are discussed and their asymptotic scattering amplitude together with their phase shifts are compared with those obtained by the eikonal method. (L.B.S.)

29380 CONDITIONS FOR DIRAC BOUND STATES IN ONE DIMENSION. Ronveaux, Andre (Facultes Univ. Notre-Dame de la Paix, Namur, Belg.). Ann. Soc. Sci. Brux. Ser. I; 85: No. 3, 249-54(30 Dec 1971).

Conditions to support a bound state are established in a Dirac theory. The conditions are derived in the one-dimensional case using the variable phase approach but can easily be extended to three dimensions. Some numerical results are checked with a square-well potential. (auth)

29381 ANALYTIC STRUCTURE OF THE DUAL RESONANT AMPLITUDE WITH ONE NONPLANAR LOOP. Karpf, A. D.; Liehl, H. J. (Univ., Freiburg i. B.). Nucl. Phys.; B39: No. 1, 149-74(1972).

A rigorous treatment of the singularities of a dual resonant amplitude with one planar loop is given. The square root branch-points of the unitarity cuts and the so called "pomeron" singularity are displayed explicitly. For this evaluation it is essential that the amplitude can be split into two parts, each with only one unitarity cut and trivial asymptotic properties in the opposite directions. An additional unphysical singularity restricting α_0 to less than $\frac{1}{4}$ is found. (auth)

29382 SIGNATURED FROISSART-GRIBOV CONTINUATION OF MULTIPARTICLE AMPLITUDES TO COMPLEX HELICITY AND ANGULAR MOMENTUM. White, A. R. (Cambridge Univ., Eng.). Nucl. Phys.; B39: No. 1, 432-60(1972).

Signatured "Froissart–Gribov" continuations in the complex angular momentum and helicity planes of a multiparticle amplitude are defined on the basis of the expected singularity structure of such amplitudes. Multiple Sommerfeld–Watson transformations of the associated partial-wave expansions are also described. A five-particle amplitude with normal threshold and pole singularities in each invariant variable is considered in detail. (auth)

29383 ANALYTIC CONTINUATION OF MULTIPARTICLE UNITARITY IN THE COMPLEX ANGULAR MOMENTUM PLANE. White, A. R. (Cambridge Univ., Eng.). Nucl. Phys.; B39: No. 1, 461-78(1972).

A diagonal form for the continuation of a multiparticle unitarity integral to complex angular momentum is given involving the "Froissart–Gribov" continuations of multiparticle amplitudes to complex helicity and angular momentum defined in a previous paper. The form for the continuation of the three-particle unitarity integral is considered in detail and shown to converge and satisfy the Carlson condition on the asymptotic behavior under quite general conditions. (auth)

29384 RIGOROUS LOWER BOUND FOR THE MAXIMUM OF THE AMPLITUDE FROM ERROR-AFFECTED DATA. Ciulli, S.; Nenciu, G. (Inst. of Atomic Physics, Bucharest). Nuovo Cim.; 8A: No. 4, 735-40(21 Apr 1972).

An algorithm is given for the computation of the lowest possible bound for a scattering amplitude given with known errors over a limited energy range. This lower bound is an important numerical quantity which characterizes the set of all admissible amplitudes and could be employed to investigate the analyticity properties of the set of all amplitudes consistent with the given information (data and errors). (auth)

29385 INFINITELY RISING TRAJECTORIES AND THE EXISTENCE OF THE MANDELSTAM REPRESENTATION. Botke, J. C. (Cambridge Univ., Eng.). Nucl. Phys.; B40: 141-50(1972).

A simple Regge dominated model based on Mandelstam analyticity is constructed which imposes an asymptotic constraint on an infinitely rising trajectory function, namely $\mathrm{Im}\alpha(s) \geq (1/\pi)\ln(s/s_0)\,\mathrm{Re}\alpha(s)$. Using this constraint as input, an integral equation is solved for the trajectory which is then compared with data. Finally, it is shown that this constraint is sufficient to guarantee the existence of the Mandelstam representation without subtractions. (auth)

29386 ASYMPTOTICS OF THE FEYNMAN DIAGRAMS THAT CONTAIN INFRARED DIVERGENCES AND COULOMB INTERFERENCE. Solov'ev, L. D.; Schelkachev, A. V. (Inst. for High Energy Physics, Serpukhov, USSR). Nucl. Phys.; B40: 596-604(1972).

The electromagnetic corrections to high-energy hadron scattering are considered in a simple relativistic model. The hadron scattering amplitude in the model is described by simple Feynman diagrams. A method to obtain the high-energy behavior of Feynman diagrams with infrared divergences is developed. The influence of form factors is investigated. In this model the radiative corrections besides those given by the well known Bethe formula are essential for the high-energy forward scattering. These corrections violate the Pomeranchuk theorem for the total cross sections. (auth)

29387 BOUND ON THE FORWARD 3-TO-3 SCATTERING AMPLITUDE. Mickens, R. E. (Fisk Univ., Nashville). Lett. Nuovo Cim.; 3: No. 12, 495-6(18 Mar 1972).

It is suggested that a bound similar to the Froissart bound may hold for the connected part of the 3-to-3 forward scattering amplitude. (L.B.S.)

29388 FINITE-ENERGY SUM RULES FOR PARTIAL WAVES AND THEIR FORMULATION FOR THE N/D EQUATIONS. Brandt, W.; Kaschluhn, F. (Humboldt Univ., Berlin, Institut fuer Hochenergiephysik, Berlin). Nucl. Phys.; B40: 457-74(1972).

Constraints for partial wave amplitudes are derived from Regge asymptotics in the form of finite-energy sum rules. For simplicity only the scattering of scalar particles is considered, and a pure Regge pole behavior of the total amplitude is assumed together with a strong enhancement of forward and backward scattering. The constraints are formulated also for the N/D equations in order to determine possible subtraction constants and CDD-pole parameters. (auth)

29389 SIMPLE AND GENERAL DERIVATION OF CONSISTENT CONTINUOUS PARAMETER SUM RULES. Czekalski de Achterberg, M.(Univ. Nacional, Buenos Aires); Ferro Fontan, C.; Violini, G. Nucl. Phys.; B40: 397-408(1972).

It is shown that generalized continuous parameter dispersion sum rules are always expressible as a series whose coefficients are the usual integer moment finite energy sum rules. Some current examples in the literature are reviewed. The essential equivalence of several kinds of sum rules is tested for the spin-averaged forward Compton amplitude and the results support our conclusion. (auth)

29390 RISING CROSS-SECTIONS. Oehme, Reinhard (Univ. of Chicago, CERN, Geneva). Springer Tracts Mod. Phys.; 61: 109-19(1972).

Amplitudes with total cross sections rising asymptotically like $(\log s)^{\beta_+}$ require shrinkage of the diffraction peak. For $0 < \beta_+ \leq 1$, it is sufficient to have a leading positive signature trajectory which is regular at $t = 0$, but not a constant. For $1 < \beta_+ \leq 2$, the trajectory must have a branch point at $t = 0$. Explicit amplitudes with complex Pomeranchuk trajectories are given which are compatible with t channel unitarity. The limiting case of maximal absorption is considered briefly. (auth)

PHYSICS (LOW-TEMPERATURE)

Superfluidity

29391 (NYO-3699-63) LIQUID HELIUM CONFIGURATION AROUND A METASTABLE EXCITED HELIUM ATOM. Hansen, J. P.; Pollock, E. L. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Nov 1971. Contract AT(11-1)-3161. 12p. Dep. NTIS.

The pair distribution for normal He atoms in the vicinity of a metastable 2^3S He atom is calculated in the zero temperature limit, from first principles, using a variational Jastrow wave function and the Percus-Yevick integral equations for fluid mixtures. From this pair function, the bubble radius, coordination number, and energy per metastable atom are calculated. (auth)

29392 SOME FEATURES OF CHARGED PARTICLE MOTION IN ^{3}He-^{4}He SOLUTIONS LOCATED IN STRONG ELECTRIC FIELDS. Esel'son, B. N.; Kovdrya, Yu. Z.; Tolkacheva, O. A. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 62: No. 2, 652-60(Feb 1972). (In Russian).

The velocities of positive and negative ions in ^{3}He-^{4}He solutions containing up to ~1% of ^{3}He are measured by the time-of-flight technique in electric fields up to 1000 V/cm and temperatures from 0.37 to 0.67°K. It is shown that the positive ion drift velocity dependence on field strength deviates from the linear extrapolation towards higher velocity values, providing the temperature is sufficiently low so that ion scattering by impurity excitations are predominant and the field strength is high. It is found that, in solutions as well as in ^{4}He, there exist two values of the critical field and velocity for which the ion motion is accompanied by the formation of quantized vortex rings. (auth)

29393 CALCULATION OF INTENSITY RATIO OF BRILLOUIN COMPONENTS IN He II UNDER PRESSURE. Ganguly, B. N. (Univ. of Illinois, Urbana). Phys. Lett.; 39A: No. 1, 11-12(10 Apr 1972).

The ratio of the intensities of Brillouin components due to first and second sound is calculated, using experimentally determined pressure dependence of specific heats ratio. The intensity of second-sound Brillouin components is found to be as strong as six tenths of that of the first sound component near critical temperature under 20 to 30 atmospheres pressure. (auth)

29394 LIGHT SCATTERING IN LIQUID HELIUM. Fetter, Alexander L. (Stanford Univ., Calif.). J. Low Temp. Phys.; 6: No. 5-6, 487-504(Mar 1972).

A quantum-mechanical formulation of light scattering in a dielectric fluid is applied to liquid helium. To lowest order in the (small) dielectric susceptibility $n\alpha$, the theory reproduces the usual expression for Brillouin scattering. Two-roton processes occur in both first and second order in $n\alpha$, and the relevant ground-state matrix elements are evaluated with Feynman wave functions in the convolution approximation. The resulting two-roton differential cross section is significantly smaller than Stephen's prediction, in good agreement with the experiments of Greytak and Yan. The depolarization is somewhat reduced from that of Stephen; present techniques should be able to detect this difference. (auth)

29395 DYNAMICAL PROPERTIES OF THE THREE-DIMENSIONAL XY MODEL. Ditzian, R. V.; Betts, D. D. (Univ. of Alberta, Edmonton). Can. J. Phys.; 50: No. 2, 129-38(15 Jan 1972).

The spin-$\frac{1}{2}$ X Y model in three dimensions is a particularly suitable model for the study of dynamical critical properties, both for comparison with experimental systems such as liquid He near T_λ and certain magnetic systems, and for testing of the predictions of dynamic-scaling theory. Sixteen coefficients were obtained in the high-frequency high-temperature expansion of the perpendicular (order-parameter) susceptibility, $\chi_\perp(\omega,T)$. Analysis of $\chi_\perp(\omega,T)$ yields estimates of dynamic critical indices not in conflict with experiment or dynamic scaling, but longer series are needed for a definitive comparison. (auth)

29396 PROPAGATION OF NEUTRAL EXCITATIONS IN He II AT T > 0.09°K. Calvani, P.; Maraviglia, B.; Messana, C. (Univ. Rome). Phys. Lett.; 39A: No. 2, 123-4(24 Apr 1972).

Neutral excitations have been observed at 0.9 < T < 2°K. They can travel distances of some millimeters and after proceeding with a random walk through the roton gas, annihilate by collision with another neutral excitation. (auth)

29397 BOSE SYSTEM WITH REPULSIVE CORE AND ATTRACTIVE TAIL. Khanna, K. M. (International Centre for Theoretical Physics, Trieste, Italy); Phukan, A. N. Physica; 58: No. 2, 263-76(15 Mar 1972).

The properties of a dilute Bose system with strong repulsive core followed by a weak attractive tail are studied by Green-function methods. From the results it is concluded that such a system possesses properties that much resemble those of liquid helium (below the lambda-transition temperature). It is also concluded that such a system is a stable assembly and its transition temperature in the liquid state is comparable to the lambda transition temperature of liquid ^{4}He. (auth)

29398 ULTRASONIC ATTENUATION IN LIQUID ^{4}He UNDER PRESSURE. Roach, Pat R.; Ketterson, J. B.; Kuchnir, M. (Argonne National Lab., Ill.). Phys. Rev., A; 5: No. 5, 2205-14 (May 1972).

In an attempt to help resolve previously observed discrepancies between the theory for ultrasonic attenuation and the data at the vapor pressure, the measurements were extended to higher pressures. Data are reported on the temperature dependence of the attenuation from 0.1 to 1.0 K at frequencies of 15, 45, 105, and 256 MHz for pressures between 0 and 24.7 atm. At low pressures or temperatures, the data resemble the theoretical predictions, but the measured attenuation is about twice that predicted by most theories. At higher pressures and for temperatures above 0.3 K, the attenuation shows a sharp reduction below the value extrapolated from low temperatures according to previous theories. It has recently been suggested that this unexpected behavior is due to a restriction on the number of thermal phonons that are able to play a part in the attenuation process at higher temperatures and pressures. (auth)

29399 LIQUID-HELIUM CONFIGURATION AROUND A METASTABLE EXCITED HELIUM ATOM. Hansen, J. P.; Pollock, E. L. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., A; 5: No. 5, 2214-16(May 1972).

The pair distribution for normal He atoms in the vicinity of a metastable 2^3S He atom is calculated in the zero-temperature limit, from first principles, using a variational Jastrow wave function and the Percus-Yevick integral equations for fluid mixtures. From this pair function, the bubble radius, coordination number, and energy per metastable atom are calculated. (auth)

29400 DEPRESSION OF T_λ BY A HEAT CURRENT. Bhagat, S. M.; Lasken, R. A. (Univ. of Maryland, College Park). Phys. Rev., A; 5: No. 5, 2297-2302(May 1972).

Earlier experiments on the He II-He I transition in a heat current were repeated in several different flow geometries in an attempt to discover the reason for discrepancies among results of various observers. Detailed analysis of the data has allowed the authors to suggest a mechanism that may account for the apparent inconsistencies. (auth)

Superconductivity

Refer also to abstracts 28614, 29470, 30112, and 30153.

29401 (LNF-72/10) NUMERICAL CALCULATION OF THE ZERO BIAS CONDUCTIVITY FOR A SUPERCONDUCTING TUNNEL JUNCTION, IN THE PRESENCE OF "DEPAIRING". Baker, K.; Paterno, G. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 8 Feb 1972. 18p. Dep. NTIS (U. S. Sales Only).

The numerical calculation of $(dI/dV)_S/(dI/dV)_N = \sigma[(\Delta_0/KT),Z]$ is presented for different values of Z (parameter of pair breaking) and for different values of $\beta = \Delta_0/KT$ when V = 0. The Fortran program used to make the calculations is given, as well as a table of values calculated with the program. Also included is a graph of σ vs Z for three values of β. (M.H.R.)

29402 INVESTIGATION OF THE RESISTIVE BEHAVIOR OF A SUPERCONDUCTOR OF THE SECOND KIND NEAR THE UPPER CRITICAL FIELD STRENGTH. Goncharov, I. N.; Khukhareva, I. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz.; 62: No. 2, 627-38(Feb 1972). (In Russian).

The volt-ampere characteristics of recrystallized Nb-80% Zr foils were measured near the critical magnetic field strength. A peak effect occurs in the immediate vicinity of H_{c_2} on the $I_c(H)$ curves. The resistive transition in the peak region is strongly smeared out, and this results in a considerable increase of the current corresponding to the given electric field. Possible causes

of this behavior are discussed. It is found that, in a certain range of magnetic field strengths, hysteresis may arise on the V(I) curves that is connected with a definite initial state of the vortex line lattice. The dependences $H_{c3}(T)$ and $H_{c3}(T)$ are determined in the temperature range from 4.2°K to 8.1°K. The value obtained for $H^*_{c3}(0)$ is compared with that predicted by the GLAG and Maki and Werthamer theories. On variation of temperature, the ratio H^*_{c3}/H^*_{c2} is found to considerably increase near T_c; this fact is in good agreement with the fluctuation theory. (auth)

29403 SUPERCONDUCTIVITY OF SINTERED Nb WITH AND WITHOUT ADDITIONS OF Al_2O_3. Best, Karl-Juergen; Pfeiffer, Irmtraut (Vacuumschmelze GmbH, Hanau, Ger.). Z. Metallk.; 63: No. 3, 152-5(Mar 1972). (In German).

The superconducting behavior of cold-worked wires of sintered Nb and Nb with additions of Al_2O_3 (maximum content 2 wt %) was investigated. It was found that the additions of Al_2O_3 had a definite influence on the values of the residual resistivity, the magnetization behavior, and the critical current density whereas T_c remained nearly unaffected. Primarily, the upper critical field H_{c2} was strongly influenced; it was increased to more than twice the value of that of pure Nb by an addition of 2 wt % Al_2O_3. The increase of H_{c2} was caused by two factors: the presence of aluminum as a solute resulting from reduction of Al_2O_3 during the sintering process and dislocation structures produced by heavy cold work which interact with Al atoms. (auth)

29404 GAP STATES IN SMALL SUPERCONDUCTING PARTICLES. Buettner, H. (Univ., Dortmund, Ger.); Gerlach, E. J. Phys., F (London); 2: No. 2, 302-5(May 1972).

Application of the Green function method by Garcia Moliner and Rubio (1969) to superconducting spheres of radius a leads to quasi-particle states in the gap if a is smaller than the coherence ξ_0. (auth)

29405 EFFECT OF HYDROSTATIC PRESSURE ON SOME CRITICAL PARAMETERS OF SUPERCONDUCTING InBi ALLOY. Papp, E. (Eotvos Lorand Univ., Budapest). J. Phys., F (London); 2: No. 2, 306-15(May 1972).

The critical temperature T_c and critical current I_c of a Type-II superconductor, in 2.5 at. % Bi ($\kappa \simeq 1$), were measured under hydrostatic pressure up to 18.2 kbar. The critical temperature decreases under pressure with an initial slope -4×10^{-5} K bar^{-1}. In the measured temperature and pressure range the critical current can be approximated by a three parameter formula. These parameters are T_c, κ, and H^*_{c2}, where H^*_{c2} is approximately 0.8 H_{c2}. The pressure dependence of I_c is determined by the pressure dependence of H^*_{c2}, T_c, and κ. (auth)

29406 FLUCTUATIONS IN SUPERCONDUCTING ALLOYS CONTAINING MAGNETIC IMPURITIES. Ludwig, A.; Zuckermann, M. J. (McGill Univ., Montreal). J. Phys., F (London); 2: No. 2, L21-4(May 1972).

Recent theoretical work indicates that the curve of the critical temperature T_{c0} against magnetic impurity concentration in Kondo superconductors may be reentrant for a range of values of T_{c0}/T_k where T_k is the Kondo temperature. T_{c0} is the superconducting critical temperature in the absence of magnetic impurities. In this case the resistivity of a thin film exhibits a minimum as a function of temperature close to the reentrant point on the curve in the presence of superconducting fluctuations. (auth)

29407 STUDY OF ULTRASONIC ABSORPTION IN THE INTERMEDIATE STATE OF PURE SUPERCONDUCTING TIN. Mahajan, S. K.; Chaudhuri, K. D. (Univ. of Delhi). Phys. Lett.; 39A: No. 1, 31-2(10 Apr 1972).

Ultrasonic absorption studies in the intermediate state of superconducting tin revealed sharp resonance peaks. Measurements were made under wide variations of ultrasonic pulse frequencies. The possibility of correlating this study with a model proposed by Claiborne and Einspruch (Phys. Rev., 132: 621(1963)) for hard superconducting alloys was explored. (auth)

29408 ETTINGSHAUSEN EFFECT IN A TWO-BAND SUPERCONDUCTOR IN THE MIXED STATE NEAR H_{c2}. Tang, I-ming (American Univ., Beirut). Phys. Lett.; 39A: No. 1, 47-8(10 Apr 1972).

Using the steady-state entropy flow equation of Van Vijfeijken and taking into account the presence of a second energy gap in the pure transition-metal superconductors, a two-band expression is obtained for the Ettingshausen effect in the pure transition-metal superconductors in the mixed state near H_{c2}. (auth)

29409 EFFECTIVE DIMENSIONALITY CHANGE OF FLUCTUATIONS IN SUPERCONDUCTORS IN A MAGNETIC FIELD. Lee, Patrick A.; Shenoy, Subodh R. (Yale Univ., New Haven). Phys. Rev. Lett.; 28: No. 16, 1025-8(17 Apr 1972).

In an external magnetic field and near the transition temperature $T_{c2}(H)$, bulk and thin-film superconductors exhibit an effective changes to one- and zero-dimensional behavior in their fluctuation specific heats, which diverge like $(T/T_{c2}-1)^{-\frac{1}{2}}$ and $(T/T_{c2}-1)^{-1}$, respectively. This enhancement effect is accompanied by a field-dependent broadening of the critical region. (auth)

29410 SUPERCONDUCTIVITY IN d- AND f-BAND METALS. Conference Held at Rochester, New York, October 29-30, 1971. Douglass, D. H. (ed.). AIP Conference Proceedings, Number 4. New York; American Institute of Physics (1972). 382p. $11.00. (CONF-711027).

Twenty-seven papers are included, with a separate abstract prepared for each of twenty-five. The other two papers appeared previously in NSA 26: abstract nos. 5366 and 21559. (M.H.R.)

For abstracts of individual papers see: 29411–29423 and 29425–29436.

29411 TRANSITION-METAL SUPERCONDUCTORS: EXPERIMENTAL SURVEY. Hulm, J. K.; Blaugher, R. D. (Westinghouse Research Labs., Pittsburgh). pp 1-16 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

The major highlights of past experimental work and current knowledge on the superconducting critical temperatures of the transition elements, their alloys and compounds are presented. The survey includes materials such as: the solid-solution alloys of the d-band transition metals; intermetallic compounds of the sigma, alpha-manganese and Laves phases; superconducting compounds of ferromagnetic elements and Group 3 elements; and high critical temperature materia's of the sodium chloride and β-tungsten structures. (64 references). (auth)

29412 COMMENTS ON THE MAXIMUM SUPERCONDUCTING TRANSITION TEMPERATURE. Cohen, Marvin L. (Univ. of California, Berkeley); Anderson, P. W. pp 17-27 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

Using current superconductivity theory and some assumptions about the normal-state properties of solids, estimates of the maximum superconducting transition temperature are made. The optimum resonant frequency for an attractive interaction, the role of umklapp scattering, and the appearance of lattice instabilities are discussed. (auth)

29413 HIGH CRITICAL FIELD MEASUREMENTS. Foner, S. (Massachusetts Inst. of Tech., Cambridge). pp 28-9 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

Only the highest-transition-temperature materials, those with high critical fields, are discussed. Materials with the approximate compositions Nb_3Al, Nb_3Ga, and $Nb_{0.75}(Al_{0.75}Ge_{0.25})_{0.25}$ are mentioned. The main results are outlined and references to recent publications are tabulated. (M.H.R.)

29414 SUPERCONDUCTIVITY OF TANTALUM, NIOBIUM, AND LANTHANUM STUDIED BY ELECTRON TUNNELING: PROBLEMS OF SURFACE CONTAMINATION. Shen, L. Y. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 31-44 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

The properties of superconducting-transition-metal tunnel junctions are sensitive to the methods of junction preparation. The derivatives of a tantalum/silver junction made by a sputtering method clearly show much poorer gap and phonon-induced characteristics than a junction made on an outgassed surface. Analysis of the latter gives $\alpha 2(\omega)F(\omega)$ with phonon peaks at energies in agreement with neutron scattering, $\mu^* = 0.11$ and $\lambda = 0.69$, in good agreement with calculated values. It is concluded that tantalum is an electron–phonon coupled superconductor. The data from niobium/gold and lanthanum/aluminum junctions are analyzed and presented. Even though the niobium and lanthanum junctions are the best ones ever made using these materials, they still possess sufficient surface contamination to affect the gap characteristic and weaken the phonon-induced structures in the tunneling characteristics. As a result, the Coulomb pseudopotentials μ^* for both Nb and La are found to be −0.04, a significant deviation from the $\mu^* = 0.1$ to 0.15 range typical of most superconductors. The electron phonon coupling strengths λ are 0.58 for Nb, and 0.66 for La,

compared to 0.82 and 0.75 expected on the basis of their T_c and θ_D. However, at present it is believed that these disagreements are the result of studying junctions with contaminated transition metal surfaces rather than evidence for a second coupling mechanism of superconductivity. (30 references). (auth)

29415 LATTICE DYNAMICS OF TRANSITION METALS. Woods, A. D. B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 45-55 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

Neutron inelastic scattering has been used extensively as a tool for the investigation of the lattice dynamics of many systems. Such measurements on transition metals and alloys suggest that the frequency vs wave vector dispersion relations for the normal modes of vibration of these crystals depend strongly on their electronic structures. Neutron measurements on d-band and, to a lesser extent, f-band metals are reviewed here, and how various features of the results are related to electronic properties is pointed out. (41 references). (auth)

29416 ENERGY BANDS FOR TRANSITION METALS AND COMPOUNDS. Mattheiss, L. F. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 57-71 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

The present status of band-structure calculations for transition metals and compounds is reviewed by considering a few selected examples of both superconducting and nonsuperconducting materials. Similarities and differences in the band structures of metals and compounds are illustrated by comparing results for the 3d metals with those for the monoxides. Analogous results are described for 4d and 5d metals, including bcc Nb, Ta, and W, and hcp Re. Finally, energy-band results are presented for several superconducting compounds, including materials with the rock-salt (NbN), β-tungsten (V_3Ga), and perovskite ($SrTiO_3$) structures. (39 references). (auth)

29417 ELECTRON–PHONON COUPLING IN THE TIGHT-BINDING APPROXIMATION. Barisic, S. (Faculte des Sciences, Orsay, France). pp 73-90 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

The tight-binding approximation is applied to the problem of the determination of the d-electron eigenstates in the deformed lattice. An effective self-consistent deformation potential is derived from the tight-binding equations for the deformed lattice. For time-dependent deformations this potential gives rise to an electron–phonon coupling. The electron–phonon coupling is used for the renormalization of the phonon frequencies on one hand and for the computation of the superconductivity coupling constant on the other hand. The instability of the shear modes in the V_3Si-like compounds is thus shown to be a phenomenon of a nature similar to the Kohn anomaly. Superconductivity in the transition metals is attributed to the d-electrons in the first place. It is argued that the high transition temperatures of some V_3Si-like compounds are not due to the softness of the shear modes, but rather to the existence of the pronounced Van Hove singularity close to the Fermi level. (auth)

29418 IMPORTANCE OF TRANSVERSE ACOUSTIC PHONONS IN A15 SUPERCONDUCTORS. Schuster, H. G. (Univ. des Saarlandes, Saarbruecken, Ger.). pp 91-3 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

It is shown that, within the Labbé–Friedel model for the A15 compounds, the transverse acoustic phonons are the most important ones for superconductivity. An experiment to test this statement is suggested. (auth)

29419 ELECTRON–PHONON COUPLING IN TRANSITION METAL AND RESONANCE SCATTERING. Chui, S. T. (Princeton Univ., N. J.). pp 95-8 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

A simple analytic formula for the electron–phonon coupling matrix elements was written. A picture of the wave function of the electrons inside the metal was obtained from calculations of the transition-metal band structure using the interpolation parameter scheme. (M.H.R.)

29420 TRANSITION TEMPERATURE OF TRANSITION-METAL SUPERCONDUCTORS. Appel, J. (Gulf General Atomic Co., San Diego, Calif.); Kohn, W. pp 99-102 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

The equation for the vertex part of a Cooper pair is developed in the Wannier representation to highlight the atomic nature of the electrons responsible for superconductivity in narrow energy bands. For a nondegenerate band and a short-range interaction between two electrons in sites $\underline{n}_1$ and $\underline{n}_2$, the transition temperature is determined by a small set of coupled integral equations in $\underline{n}_1$ and $\underline{n}_2$ and in the energy variable ω. With a contact interaction, $\underline{n}_1 = \underline{n}_2$, only a single equation in ω remains as the defining equation for T_c. The solution has the BCS form with an attractive interaction depending on a phonon Green's function in site space and with a repulsive interaction determined by the intra-atomic Coulomb integral U. The isotope effect is calculated as a function of U; the result can account for small negative or even positive effects as observed on transition metals. For a degenerate band, the vertex part depends on the site variables $\underline{n}$ and on the orbital indices i, the latter denoting a set of localized orbitals which transform according to a degenerate representation of the crystal group. Methods of group theory are used to show how to construct appropriately symmetrized pair states in this atomic representation. Specific applications to s and d bands in bcc and fcc lattices and to d bands in β-tungsten structures have been worked out. (auth)

29421 THEORY FOR SUPERCONDUCTIVITY IN d-BAND METALS. Bennemann, K. H. (Univ. of Rochester, N. Y. Argonne National Lab., Ill.); Garland, J. W. pp 103-37 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

Superconductivity in transition metals, in transition metal alloys, in A15 compounds and in U_6X compounds is studied within the framework of the BCS theory. The electron–phonon coupling constant λ is expressed in terms of measurable normal-state quantities and an atomic parameter. Then, using the McMillan formula for the superconducting transition temperature T_c, the variation of T_c in the three transition metal series is discussed. Calculated values for T_c are given for several transition metal alloys, U_6X compounds and for Sc, Y, Lu, and La. Also, it is shown that in A15 compounds, Cooper pair fluctuations may occur even at temperatures several degrees Kelvin above T_c. (29 references). (auth)

29422 SUPERCONDUCTIVITY OF Nb_3Ga. Webb, G. W. (RCA Labs., Princeton, N. J.). pp 139-43 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

Stoichiometric Nb_3Ga was prepared with $T_c = 20.3$°K. Experiments show T_c to be a sensitive function of lattice parameter, composition, and annealing temperature. These variables are connected with unusual features of the phase diagram, the most interesting of which is that the stoichiometric composition is stable only below 700°C. The phase boundaries are discussed qualitatively in terms of the free energy function for the β-W phase. (auth)

29423 RELATION OF NORMAL AND SUPERCONDUCTING PROPERTIES TO THE ELECTRONIC DENSITY OF STATES. Cohen, Roger W. (RCA Labs., Princeton, N. J.). pp 144-5 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

Recent experiments on the magnetic susceptibility and elastic constants of single-crystal, transforming Nb_3Sn cannot be interpreted consistently in terms of simple one-dimensional band models. The results indicate that the one-dimensional band models greatly oversimplify the behavior of the density of states of Nb_3Sn in the vicinity of the Fermi level. (M.H.R.)

29424 PHONON SPECTRA AND SUPERCONDUCTIVITY IN SOME TRANSITION METAL CARBIDES. Smith, H. G.; Glaeser, W. (Oak Ridge National Lab., Tenn.). pp 145-9 of Phonons. /Nusimovici, M. A. Paris; Flammarion Sciences (1971).

From International conference on phonons; Rennes, France (26 Jul 1971).

The phonon spectra of TaC, HfC, $NbC_{0.95}$, $NbC_{0.76}$ and $UC_{0.95}$ were studied. Anomalies observed in the phonon branches of superconducting $NbC_{0.98}$ do not occur with nonsuperconducting $NbC_{0.76}$ and $UC_{0.95}$. These anomalies are probably due to strong electron–phonon interactions and indicate high-transition-temperature superconductors. (auth)

29425 SUPERCONDUCTIVITY OF RARE EARTHS AND ACTINIDES. Coqblin, B.; Galleani d'Agliano, E.; Jullien, R. (Faculte des Sciences, Orsay, France). pp 154-74 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

Some aspects of the superconductivity of rare-earths and actinides are discussed: The pressure dependence of the superconductivity of lanthanum is explained under the assumption of a valence a little smaller than 3. Some new experimental evidences could support this assumption. Superconductivity of cerium metal and alloys is briefly reviewed. A simple model for actinide metals and alloys is presented for explaining the occurrence of localized magnetism only for curium and the superconductivity of actinide impurities in lanthanum. (54 references) (auth)

29426 SPIN-EXCITATION EFFECTS IN SUPERCONDUCTORS. Maple, M. B. (Univ. of California, San Diego, La Jolla). pp 175-203 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

Spin-excitation effects in superconductors are discussed, with an emphasis on experiment. First, a review is presented of the superconductivity in dilute alloy systems that exhibit localized spin fluctuations associated with resonant impurity states. It is shown that when the localized spin fluctuation temperature is much larger than superconducting temperatures: (1) the transition temperature falls off rapidly with impurity concentration following a modified exponential, and (2) the thermodynamic properties (e.g., the specific heat jump at the transition and the critical field) obey the BCS law of corresponding states. A comparison is made to a recent theory by Kaiser of superconductivity in the presence of nonmagnetic resonant impurity states. Next, experiments on La and La intermetallic compounds with Ce impurities, which simultaneously exhibit superconductivity and the Kondo effect, are reviewed. Finally, pressure-induced magnetic-nonmagnetic transitions of Ce impurities in superconductors are discussed and compared with certain theoretical models. (70 references). (auth)

29427 THIN-FILM STUDIES OF HIGH-T_c COMPOUNDS. Ashkin, M.; Deis, D. W.; Gavaler, J. R.; Jones, C. K. (Westinghouse Research Labs., Pittsburgh). pp 204-12 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

Thin films of NbN and Nb–Al–Ge have been shown to exhibit interesting and sometimes dramatic effects in their critical parameters, J_c, H_{c2}, and T_c, when compared with their corresponding properties in bulk. Many of these results can be explained in terms of the structure of these films. A monotonic relationship between T_c and reciprocal Hall constant was observed for short mean free path materials having the rocksalt structure, suggesting that their superconducting properties are rather insensitive to minor details of the Fermi surface topology. The above results are presented in some detail and compared with the theories of Type-II superconductors wherever possible. (auth)

29428 MEASUREMENTS ON A15 FILMS. Cadieu, F. J. (Univ. of Rochester, N. Y.). pp 213-22 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

A method for the preparation of A15 superconducting films by co-sputtering is presented. This method is useful for the study of both alloying effects and crystal-structure-stability determinations. Measurements in the A15 systems Nb_3Al, $Nb_3Al_{.75}Ge_{.25}$, and V_3Si prepared by this method are presented. In addition, a new method for the preparation of V_3Si by reactive diffusion is presented. (auth)

29429 SOME PROPERTIES OF TRANSITION-METAL SUPERCONDUCTORS AT SURFACES AND IN THIN FILMS. Strongin, Myron (Brookhaven National Lab., Upton, N. Y.). pp 223-36 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

Low energy electron diffraction (LEED) and Auger spectroscopy measurements on Nb surfaces are described and the results are related to some of the problems encountered in the design of superconducting rf cavities. Possible protective coverings for the Nb surfaces that are used in these cavities are discussed, and experiments on one type of covering, i.e., thin layers of Nb_3Sn grown on Nb, are described. Finally, experiments on amorphous transition-metal films are presented, and the results of the measurements are discussed in the context of LEED measurements of θ_D at the niobium surface. (auth)

29430 LAYERED TRANSITION-METAL DICHALCOGENIDES. Geballe, T. H. (Stanford Univ., Calif. Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 237-42 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

It is suggested that electron–electron attractive interactions within single molecular sheets of TaS_2, NbS_2, and $NbSe_2$, with their electron densities only slightly changed by intercalation, lead to large fluctuations near 3°K. It is predicted that a Hall effect reversal in sign will take place in the trigonal $NbSe_2$, with four-fold stacking at temperatures above 26°K, and that it will be suppressed below 26°K for the 2-fold phase under pressure or stress along the c-axis. Two approaches for searching for higher-temperature superconductivity in layered structures are suggested. (M.H.R.)

29431 SUPERCONDUCTIVITY IN INTERCALATED MOLYBDENUM DISULFIDE. Somoano, R.; Hadek, V.; Rembaum, A. (California Inst. of Tech., Pasadena). pp 243-53 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

Superconductivity was observed in the Na, K, and Rb intercalates of molybdenum disulfide (MoS_2). The superconducting transitions are wide (several degrees) and not complete down to the lowest temperature studied (~.6°K). The onset of superconductivity ranged from ~6.5°K for the potassium and rubidium compounds to ~4.5°K for the sodium compounds. A two-phase type of transition was observed only for the potassium intercalated compounds. An x-ray analysis of these systems indicated: (1) partial intercalation of some of the samples; (2) expansion of the unit cell upon intercalation; and (3) possible existence of two different expansions in the potassium and sodium compounds. An investigation of the effect of crystal orientation on the superconducting transition is in progress. (auth)

29432 PRESSURE DEPENDENCE OF T_c: THEORY FOR THE PRESSURE DEPENDENCE OF T_c FOR NARROW-BAND SUPERCONDUCTORS. Garland, J. W. (Univ. of Illinois, Chicago. Argonne National Lab., Ill.); Bennemann, K. H. pp 255-92 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

A theory for the pressure dependence of T_c in narrow-band superconductors is proposed. New physical mechanisms which, in transition metals, lead to an increase under pressure in the Hopfield parameter η and, in some cases, even an increase in T_c are discussed. It is shown how investigations of the pressure dependence of T_c may give information on the importance of lattice instability and/or spin fluctuations on T_c. Approximate calculated values of $\partial T_c/\partial p$ are presented for all superconducting transition-metal elements and for a few compounds. These calculations are based on the theoretical model for the superconductivity of d-band metals presented earlier in this conference. This microscopic theory also quantitatively supports the original phenomenological explanation by Hopfield of the high T_c of some A15 compounds. Specific measurements are proposed to facilitate further testing of various models for the superconductivity of transition metals and compounds. (83 references). (auth)

29433 DETERMINATION OF PRESSURE DEPENDENCE OF T_c FOR d- AND f-BAND SUPERCONDUCTORS. Smith, T. F. (Univ. of California, San Diego, La Jolla). pp 293-319 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

Determinations of the pressure dependence of the superconducting transition temperature for the d and f band superconductors are reviewed and the various outstanding features discussed. (92 references). (auth)

29434 CHEMISTRY OF HIGH-TEMPERATURE SUPERCONDUCTIVITY IN THE NbN FAMILY. Phillips, J. C. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 339-57 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

The high transition temperatures T_c of the family of RY compounds (R = Tl, Zr, Hf, V, Nb, or Ta; Y = C, N, or O) are attributed to softness of the lattice against hydrostatic deformations, which gives rise to strong electron–longitudinal acoustic phonon coupling at short wavelengths. Chemical trends within the RY family provide evidence to support this explanation. The microscopic theory of superconductivity is used to predict from the value of T_c the form of the phonon spectrum of NbN. For the acoustic branch the predicted value of $\langle\omega^2\rangle^{1/2}$ is 150°K. Also T_c(max.) in the RY family is estimated to be 22°K. (27 references). (auth)

29435 INFRARED PROPERTIES OF TRANSITION METALS. Hopfield, J. J. (Princeton Univ., N. J.). pp 358-66 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

The usefulness of optical measurements in the 1- to 20-μ region in the understanding of electron–phonon coupling in transition metals is discussed. There are many possible barriers in the way of exact simple relations of optical constants to superconductivity, and some of these are described. In many transition metals the relaxation rate has the form $\alpha + \beta\omega^2$. Possible origins of the term are given, of which the two most interesting are the rapid variation of parameters near the Fermi energy, and electron–electron collisions. It is shown that the measured Baber resistivity term in palladium is in qualitative agreement with this interpretation of the $\beta\omega^2$ optical relaxation rate in palladium. (auth)

29436 HIGHER TEMPERATURES AND INSTABILITIES. Matthias, Bernd T. (Univ. of California, San Diego, La Jolla. Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 367-75 of Superconductivity in d- and f-Band Metals. /Douglass, D. H. (ed.). New York; American Inst. of Physics (1972).

From Conference on superconductivity in d- and f-band metals; Rochester, N. Y. (29 Oct 1971).

Various instabilities that are obstacles to producing higher-temperature superconductors are discussed: shear, difficulties in formation, ferroelectricity, and ferromagnetism. A quartenary system is suggested as a possible way to higher temperature superconductors. (M.H.R.)

29437 MUTUAL DEPENDENCE BETWEEN THE SUPERCONDUCTING PROPERTIES OF ALLOYS AND THEIR ELASTIC STRESSES. Baikov, A. I. Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 32: 93-8(1971). (In Russian).

A method is described for determining the residual elastic stress values in a wire. Results are given for superconducting Nb–Ti alloys in relation to their compositions. (Referativnyi Zh.)

29438 CONDITIONS FOR THE FORMATION OF THE SUPERCONDUCTING COMPOUND V_3Ga OBTAINED BY A DIFFUSION METHOD. Vorob'eva, N. S.; Kunakov, Ya. N.; Ronami, G. N.; Kuznetsova, S. M. Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 32: 115-23(1971). (In Russian).

A heat-treatment regime for the preparation of the superconducting compound V_3Ga is described. (Referativnyi Zh.)

29439 SUPERCONDUCTIVITY INDUCED BY THE APPLICATION OF HIGH PRESSURES TO THE La–S SYSTEM. Vereshchagin, L. F.; Evdokimova, V. V.; Novokshonov, V. I. (Inst. of High-Pressure Physics, Moscow). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 8, 2074-5(Feb 1972).

Translated from Fiz. Tverd. Tela; 13: No. 8, 2474-5(Aug 1971).

Lanthanum sulfide, β–La_2S_3, in the form of a dull yellow–green powder, was compacted into dense cylindrical blanks of 3-mm diam. and 2.5 to 3 mm high. These blanks were subjected to pressures up to 100 kbars and temperatures up to 1800°C. The presence of five superconducting phases was shown with the following transition temperatures: 5.9 to 6.6, 7.2 to 7.6, 8.3 to 8.6, 10.4 to 10.7, and 14.1 to 14.5. The ranges given represent the transition temperatures obtained for different samples. (M.H.R.)

29440 POSSIBLE STATES OF QUASI ONE-DIMENSIONAL SYSTEMS. Dzyaloshinskii, I. E.; Larkin, A. I. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 2, 791-800(Aug 1971). (In Russian).

It is demonstrated that a quasi one-dimensional system may exist in three states: in that of an ordinary metal, in the superconducting state, and in an antiferromagnetic dielectric state. The antiferromagnetic state is observed only if the number of electrons in the unit cell is exactly equal to unity. The relations between the interaction constants ensuring a given state is determined. A comparison is made with the results for models susceptible to exact solution. Magnetic susceptibility corrections which depend logarithmically on the temperature or magnetic field are evaluated. (auth)

29441 COMPOUNDS IN THE NIOBIUM–TIN SYSTEM AND THE PREPARATION OF SUPERCONDUCTING STRIP OF Nb_3Sn. Kunakov, Ya. N. Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 32: 111-15(1971). (In Russian).

Data are presented from a study of intermediate compounds obtained in the diffusion layers in Nb/Sn systems when annealed in the range 600 to 1600°C. Preliminary results from the preparation of flexible superconducting strips of Nb_3Sn are described. (Referativnyi Zh.)

29442 SUPERCONDUCTING TUNNELLING BARRIERS. Schroen, Walter Hans Paul (to Texas Instruments Inc.). British Patent 1,269,702. 6 Apr 1972. Priority date 15 Jul 1968, United States.

A method of interconnecting the energy barriers coupling superconductors in an array is described, comprising forming energy barriers between pairs of superconductors in the array. Each energy barrier is formed so as to be capable of electromagnetic radiation generation. A dielectric material contacting the barriers is patterned to define waveguides for interconnecting the energy barriers with an approximate impedance match between the barriers and the wave guide to transport electromagnetic radiation, particularly that emitted by the energy barriers themselves. (M.H.R.)

29443 SUPERCONDUCTING PROPERTIES OF V_3Si PRODUCED BY REACTIVE DIFFUSION. Cadieu, F. J.; Johnson, G. R.; Douglass, D. H. (Univ. of Rochester, N. Y.). J. Low Temp. Phys.; 6: No. 5-6, 529-31(Mar 1972).

The superconducting properties of specially prepared V_3Si films were studied. The films studied were produced in two steps: vanadium was first sputtered onto silica glass substrates, then the film and substrate were heated. Above a definite threshold temperature, the vanadium combined with the silicon atoms in the glass to form V_3Si. (auth)

29444 EFFECT OF MANGANESE ON THE SUPERCONDUCTIVITY OF ALUMINUM. Smith, Frederick W. (Rutgers–The State Univ., New Brunswick, N. J.). J. Low Temp. Phys.; 6: No. 5-6, 435-43(Mar 1972).

The superconducting critical fields of pure aluminum and of two AlMn alloys, containing 440 and 900 ppM Mn, were measured as a function of temperature T from their transition temperatures T_c down to T = 0.07 K. The observed T_c depression can be understood in terms of Kaiser's theory for nonmagnetic localized states in superconducting alloys, with an effective Coulomb "coupling constant" $N_d(0)U_{eff}$ equal to 0.43 for the AlMn alloys. Additional evidence that the Mn impurities do not possess a well-defined magnetic moment in aluminum in this temperature range is obtained from the critical field results. In particular, the BCS law of corresponding states is obeyed by these alloys. It is concluded that these AlMn alloys can be considered BCS superconductors, with a pairing interaction which is weaker than that in pure aluminum. (auth)

29445 TYPE II SUPERCONDUCTORS CONTAINING MAGNETIC IMPURITIES. Maki, Kazumi (Tohoku Univ., Sendai). J. Low Temp. Phys.; 6: No. 5-6, 505-19(Mar 1972).

A theoretical study was made on the equilibrium as well as on the dynamical properties of type-II superconductors containing magnetic impurities. The Kondo effect associated with the impurity spins is taken into account within the pole approximation, which has been used previously by Müller–Hartmann and Zittarz in their calculation of the superconducting transition temperature. In this approximation the additive law of the different pair-breaking mechanisms for the transition temperature remains; the sum of the pair-breaking parameters due to magnetic impurities and due to magnetic fields is a universal function of the temperature. Since the pair-breaking parameter arising from magnetic impurities has the maximum at $T \cong T_K$, the upper critical field $H_{c2}(T)$ reflects the Kondo effect in the

system. The $\kappa_2(T)$ parameter, which describes the magnetization as well as the flux-flow resistivity of the vortex state, is obtained. When $T_K/T_{c0} > 1$, $\kappa_2(T)$ increases as the temperature decreases, but when $T_K/T_{c0} < 1$, $\kappa_2(T)$ first increases as the temperature decreases, then passing a maximum and decreasing at low temperatures, which is in sharp contrast to that obtained previously where the impurity scattering was treated with the Born approximation (i.e., the Kondo effect was completely neglected). A brief discussion of the density of states in the gapless region is also given, which reflects the Kondo effect in an interesting way. (auth)

29446 SUPERCONDUCTING PROPERTIES OF $Nb_3(Al,Ge)$ PREPARED BY VACUUM VAPOR DEPOSITION OF THE ELEMENTS. Hammond, R. H.; Ralls, K. M.; Meyer, C. H. Jr.; (and others) (Gulf General Atomic Co., San Diego, Calif.). J. Appl. Phys.; 43: No. 5, 2407-13(May 1972).

Properties of films of the niobium–aluminum–germanium system prepared by simultaneous deposition of the individual constituents are presented. The optimum superconducting material obtained contains a large fraction of the desired A15 compound and has an as-deposited critical temperature of over 17.8 K. Appropriate annealing increases T_c to above 19 K and probably close to values attained on bulk material. Current capacity is above 10^5 A/cm^2 at 50 kOe. Limitations in sample properties have been caused by the substrate material, either Hastelloy B or niobium. Preliminary indications show that the use of tungsten-coated Hastelloy B will avoid these limitations. (auth)

29447 HARMONIC GENERATION BY RESISTIVE FEEDBACK FROM SUPERCONDUCTING POINT CONTACTS. Adde, R.; Vernet, G. (Paris Univ., Orsay, France). J. Appl. Phys.; 43: No. 5, 2405-6(May 1972).

The rf emission from a superconducting point contact driven with a constant current source allows the direct observation of harmonic generation by purely resistive feedback. The amplitudes of the harmonics are shown to be in agreement with the theoretical values determined from a simple model of the junction. (auth)

29448 SUPERCONDUCTIVITY IN CUBIC AND MONOCLINIC "TiO". Reed, T. B. (Massachusetts Inst. of Tech., Lexington); Banus, M. D.; Sjoestrand, M.; Keesom, P. H. J. Appl. Phys.; 43: No. 5, 2478-9(May 1972).

The cubic metallic oxide "TiO_x" exists over the wide homogeneity range $0.8 < x < 1.30$. Though the compound was previously reported to be superconducting above 0.08°K only over the center portion of this range, measurements on well-characterized samples show that the transition temperature is relatively independent of composition and lies between 0.6 and 0.9°K for the whole range. Transition temperatures reported for several compositions annealed at 60 kbar that had not been measured previously, and the superconductivity of the monoclinic ordered structure $TiO_{1.0}$ is discussed. Some scatter in the data is attributed to the tendency of other compositions to form ordered structures on cooling. (auth)

29449 SUPERCONDUCTIVITY AND HYSTERESIS IN INDIUM–CADMIUM ALLOYS. Inhaber, Herbert. Norman, Okla.; Univ. of Oklahoma (1971). 177p. University Microfilms Order No. 72-9036.

Thesis.

The face-centered cubic phase of the indium–cadmium system (from 6 to about 20 at.% Cd) exhibits Type-II superconductivity. This phase has not been investigated previously due to the low solubility of Cd in In at these concentrations, at room temperature. This problem was eliminated by quenching the annealed alloys in liquid nitrogen. The magnetization was measured by the ballistic throw method. As in many Type-II superconductors, magnetic hysteresis was observed, and this obscured the determination of the critical field H_c and H_{c_1}, as well as the calculated Ginzburg–Landau parameters. A theory was devised to convert the irreversible data into reversible data. The theory was based on taking account of fluxoid–fluxoid (the physical entities which carry magnetic flux in a Type-II superconductor, in Abrikosov's theory) interactions at greater distances than that of nearest neighbors. As well as dealing with these interactions and their relationship to pinning centers, a model reversible curve was proposed which agrees well with the Abrikosov theory in regions for which exact solutions can be found. This theory of hysteresis was used to convert the experimental data into reversible data. The experimental critical temperatures decreased rapidly from the low-concentration fcc zone boundary to about 12 at.% Cd, and remained constant at about 3.0 K for higher concentrations. The critical fields were fitted to a parabola-correction model of Sheahen. The computed reversible data were both less erratic and more in agreement with theory than the raw irreversible data. The data were used to find other superconducting parameters like the electron–electron interaction strength, the electronic coefficient of specific heat, and the coherence length. Most show an extremum or change of slope around 12 at.% Cd, which may be due to Brillouin zone–Fermi surface interactions, as described by Merriam. The Ginzburg–Landau parameters κ_1, κ_2, and κ_3 were calculated. The first two showed only approximate agreement with the theory of Eilenberger. κ_3 showed the appropriate variation with temperature as predicted by Serin, when the reversible data were used. The amount of flux trapping at H = 0 was very small, indicating good metallurgical homogeneity in the samples. (Diss. Abstr. Int., B)

29450 MANIFESTATION OF THE EXCITON MECHANISM IN THE CASE OF GRANULATED SUPERCONDUCTORS. Ginzburg, V. L. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 14: No. 10, 396-9(20 Nov 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 10, 572-5(20 Nov 1971).

To interpret experiments on the role of the exciton mechanism in the case of granulated superconductors, it is desirable to have at least approximate formulas that make it possible to estimate the force exerted on T_c by different parameters, primarily the granule dimensions. An attempt is made to derive such formulas. It is suggested that the dielectric matrix in granulated superconductors be made of different dielectrics (not Ge) with distinct exciton bands lying much lower than the Fermi energy of the metal. (M.H.R.)

29451 TRANSPARENCY OF THICK SUPERCONDUCTING FILMS. Gor'kov, L. P.; Fedorov, M. A. (Inst. of Theoretical Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 14: No. 10, 393-6(20 Nov 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 10, 568-72(20 Nov 1971).

The possibility of passage of electromagnetic radiation through sufficiently thick films of a pure superconductor is investigated; this possibility is associated with the large mean free path of the normal excitations. The calculation of the coefficient of transmission through a relatively thick film is carried out under the condition of diffuse reflection of the electrons from the film boundary for, in this case, the reflected wave can be neglected. For indium, the calculations indicate an observable effect. (M.H.R.)

29452 THERMALLY ACTIVATED GLIDE IN NORMAL AND SUPERCONDUCTING INDIUM. Hutchison, T. S.; McBride, S. L. (Royal Military Col. of Canada, Kingston, Ont.). Can. J. Phys.; 50: No. 1, 64-6(1 Jan 1972).

Evidence is presented which shows that the flow-stress difference in normal and superconducting indium may be attributed to differences in thermal activation of glide dislocations. (auth)

29453 EFFECT OF AN OSCILLATORY MAGNETIC FIELD ON THE MIXED STATE OF A DIRTY TYPE-II SUPERCONDUCTOR. Tang, I-ming (American Univ., Beirut). Phys. Lett.; 39A: No. 2, 107-8(24 Apr 1972).

It is shown that the enhancement of the resistive voltage in the mixed state of a dirty Type-II superconductor in the presence of an oscillatory ac magnetic field can be explained qualitatively by the nonlinear response theory for a dirty Type-II superconductor developed by Maki. (auth)

29454 MCMILLAN'S EQUATION AND THE T_c OF SUPERCONDUCTORS. Dynes, R. C. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Solid State Commun.; 10: No. 7, 615-18 (1 Apr 1972).

Compiling available superconducting tunneling data, experimentally measured critical temperatures are compared with those calculated using the McMillan equation (Phys. Rev. 167: 331 (1968)). It is found that this equation gives T_c quite accurately for all these materials when the average phonon energy $\langle\omega\rangle$ is defined in one particular way. (auth)

29455 OSCILLATIONS OF THE FLUCTUATION CONDUCTIVITY OF THIN-WALLED SUPERCONDUCTING CYLINDERS IN A MAGNETIC FIELD. Kulik, I. O.; Mal'chushenko, K. V. (Physical-Technical Inst. of Low Temperatures, Kharkov). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 10, 2474-7(Apr 1972).

Translated from Fiz. Tverd. Tela; 13: No. 10, 2945-50(Oct 1971).

The nonsteady-state Ginzburg–Landau equation, which contains on its right side the random "force" S(r,t) with a white-noise spectrum, is used to calculate the fluctuation part of the longitudinal conductivity of a hollow superconducting cylinder in a magnetic field which is parallel to its axis. As a consequence of the previously considered "flux quantization" effect for T >

T_c (which gives rise to a circulating current which oscillates as a function of the flux φ), the longitudinal conductivity also oscillates, as φ changes, with a period equal to $\varphi_0 = hc/2e$. The amplitude of the p-th oscillating harmonic of σ is, in order of magnitude, $\sigma_p' \sim \sigma_{AL}' \cdot (pL/\xi(T))^{1/2} \exp\{-pL/\xi(T)\}$, where $\sigma_{AL}' = [e^2/16\hbar d]\,[T/(T - T_{c0})]$ is the fluctuation conductivity of an Aslamazov–Larkin film, L is the length of the perimeter of the cylinder section, and $\xi(T)$ is the temperature-dependent radius of coherence. The effect may be observed for cylinders of small radius at temperatures fairly close to T_c. (auth)

29456 CHANGE IN THE CRITICAL TEMPERATURE OF ORDINARY SUPERCONDUCTORS. Kresin, V. Z. (Moscow State Correspondence Pedagogical Inst.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 10, 2468-73(Apr 1972).
Translated from Fiz. Tverd. Tela; 13: No. 10, 2937-44(Oct 1971).

An analytical expression based on the phonon model is obtained for the critical temperature of ordinary superconductors with weak coupling; the expression is valid for any arbitrary phonon-dispersion law $\omega(q)$. The temperature T_c is a quantity substantially dependent on the character of the phonon spectrum. In the case of an acoustic dispersion law $\omega = uq$, the results of the ordinary theory are obtained. The possibility of a rise in critical temperature due to the effect on the phonon spectrum is discussed. The question of the dependence of T_c on the electron concentration observed experimentally is considered. The nature of the $\omega(q)$ relationship may affect the function $T_c(n)$. Expressed as a function of the electron concentration, the critical temperature may pass through a maximum. (auth)

29457 EFFECT OF IRRADIATION BY HIGH-ENERGY NITROGEN IONS ON THE NIOBIUM CRITICAL CURRENT. Tsypkin, S. I.; Chudnova, R. S. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 10, 2588-9(Apr 1972).
Translated from Fiz. Tverd. Tela; 13: No. 10, 3088-90(Oct 1971).

Foils of unannealed and annealed Nb were irradiated with 10- to 40-MeV N ions. Irradiation of the unannealed samples had no effect on the superconducting properties while, in the annealed samples, the critical current was increased, resistivity was somewhat decreased, and the critical field H_{c2} was increased slightly. The results indicate that the defects initially present prevent the formation of accumulations of point defects in clusters which are capable of affecting the critical current. (D.L.C.)

29458 MIXED-PLANE-WAVE EFFECTS ON THE ELECTRON–PHONON INTERACTION ON Pb AND Al. Yorke, E. D. (Univ. of Maryland, Baltimore); Bardasis, A. Lett. Nuovo Cim.; 2: No. 24, 1228-30(11 Dec 1971).

The effects of mixing of plane waves on the electron–phonon coupling constant λ in superconductors are discussed. The importance of the mixed-plane-wave electron states in computing λ as a consequence of the shape of the pseudopotential is examined for Pb and Al. Calculated results are presented for the umklapp vectors for the second Brillouin zones, attractive and repulsive parts of the pseudopotential, and wave vector where the pseudopotential changes sign. The dominant contribution to λ is seen to come from the $\exp[ik \cdot r]$ term in the Bloch state, and the mixing terms are smaller by one or two orders of magnitude. (D.L.C.)

29459 RESISTANCE RESULTING FROM FLUX DRIFT IN TYPE II SUPERCONDUCTORS. Fischer, Gaston. Phys. Can.; 27: No. 6, 70-2(1 Jul 1971). (In French).

The theory of type-II superconductors is briefly discussed, based largely on the work of J. Bardeen and M. J. Stephen (Phys. Rev., 140: A1197(1965)). An expression for resistivity resulting from the derivative of the lines of flux is first derived, neglecting the Hall effect. Two methods of introducing the Hall effect are considered, and the theory is developed to give a quantitative approach to the Hall field and the Hall angle. (Canada)

29460 CRITICAL-FIELD CURVE OF SUPERCONDUCTING LEAD. Chanin, G.; Torre, J. P. (Centre National de la Recherche Scientifique, Verrieres-le-Buisson, France). Phys. Rev., B; 5: No. 11, 4357-64(1 Jun 1972).

The critical field of pure monocrystalline lead was measured throughout its range. A vibrating phase-boundary technique was used, permitting continuous observation of the boundary between the normal and superconducting phases within the sample. Because of the coexistence of both phases at all times, supercooling and superheating effects are avoided. Departures from thermodynamic equilibrium are small, as is indicated by the very weak hysteresis (as low as several parts in 10,000). The deviation curve is strongly positive, as expected for strong-coupling superconductors. The measured values of the usual superconductive parameters are $T_c = (7.195 \pm 0.006)°K$, $H_0 = 803.4 \pm 0.3$ Oe, $dH_c/dT/_{Tc} = 237.3 \pm 1.1$ Oe/°K. (auth)

29461 SUPERCONDUCTING ENERGY GAP OF THORIUM DETERMINED BY ELECTRON TUNNELING. Haskell, B. A.; Keeler, W. J.; Finnemore, D. K. (Iowa State Univ., Ames). Phys. Rev., B; 5: No. 11, 4364-7(1 Jun 1972).

Electron-tunneling measurements were performed over the temperature range 0.4 to 1.4 K on $Th/ThO_2/Au$ tunnel junctions fabricated on the surface of polycrystalline thorium substrates. Both the temperature dependence of the energy gap and the voltage dependence of the tunneling density of states agree rather well with the theoretical predictions for a weak-coupling superconductor. No significant phonon-induced structure was observed in the tunneling density of states. (auth)

29462 FLUCTUATION-INDUCED CONDUCTIVITY OF SUPERCONDUCTORS ABOVE THE TRANSITION TEMPERATURE: REGULARIZATION OF THE MAKI DIAGRAM. Keller, Joachim; Korenman, Victor (Univ. of Maryland, College Park). Phys. Rev., B; 5: No. 11, 4367-75(1 Jun 1972).

The Maki contribution to the conductivity above the superconducting transition temperature is regularized within the framework of the BCS theory. This is achieved through the renormalization of the impurity-scattering vertex by inclusion of the effects of pair fluctuations. The conductivity is evaluated for a thin film. It depends only on the reduced temperature and the normal resistance per square. Fair agreement is found with Al films over a wide temperature range. Agreement is not found with experiments on Bi, Pb, and Ga films, which apparently contain a strong additional pair-breaking effect. The temperature range in which interactions among fluctuations become important in the Maki conductivity is generally larger than that given by the Ginzburg criterion. (auth)

29463 RESISTIVE TRANSITION IN A SUPERCONDUCTING FILAMENT. Londergan, R. J.; Langer, J. S. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., B; 5: No. 11, 4376-81(1 Jun 1972).

The contribution of thermal fluctuations to the conductivity of a narrow superconducting filament is examined. A Fokker–Planck equation based on time-dependent Ginzburg–Landau theory is used to describe the system. A variational solution of this equation yields an upper bound for the resistivity as a function of temperature in the limit of small electric field. The result is accurate above T_c and appears to be a better estimate of the resistivity at and just below T_c than that given by previous calculations. (auth)

29464 CRITICAL TEMPERATURE OF SUPERCONDUCTING ALLOYS WITH TRANSITION-METAL IMPURITIES-FUNCTIONAL-INTEGRAL METHOD. Theumann, Alba (CEN de Saclay, Gif-sur-Yvette, France). Phys. Rev., B; 5: No. 11, 4382-9(1 Jun 1972).

An equation for the critical temperature of dilute superconducting alloys is derived by the method of functional integrals, considering that transition-metal impurities are represented by the Hamiltonian of Anderson. The results obtained in the static approximation and symmetric case are shown to describe the magnetic–nonmagnetic transition observed in alloys with Ce impurities. (auth)

29465 EMITTED PHONON SPECTRUM AND ITS INFLUENCE ON THE DETECTED SIGNAL IN SUPERCONDUCTING Sn DIODES. Dayem, A. H.; Wiegand, J. J. (Bell Telephone Labs., Holmdel, N. J.). Phys. Rev., B; 5: No. 11, 4390-4403(1 Jun 1972).

It was observed experimentally that the detected signal-vs-generator current deviates from linearity. The deviation has a shape similar to that of a Lorentzian. Preliminary arguments lead to the conclusion that if the maximum deviation occurs at a generator voltage V_m, the emitted recombination peak should tend to a width given by $V_m - 2\Delta$. By calculating the spectrum of phonons emitted at a given generator voltage and hence the detector response signal, it is shown that the above prediction is essentially correct. A brief discussion is also given on the behavior of a superconductor when used as a phonon frequency convertor. (auth)

29466 HALL EFFECT IN DIRTY TRANSITION-METAL SUPERCONDUCTORS NEAR THE UPPER CRITICAL FIELD. Chow, W. S. (Univ. of Cincinnati. Chinese Univ. of Hong Kong). Phys. Rev., B; 5: No. 11, 4404-10(1 Jun 1972).

The two-band model is used to explain the Hall effect in dirty type-II transition-metal superconductors immediately below the upper critical field $H_{c2}(T)$. It is shown that because of the existence of interband impurity scattering, which corresponds to an interband impurity-scattering relaxation time τ_{ds}, the d-band Hall angle $\alpha_d(T)$ is given by $\tan\alpha_d(T) = \eta_d(H) + \eta_d(H_{c2})\,[X(t)/\tau_{ds}\epsilon_{d0}]/\{4K_3^2(0)\,(1 - H/H_{c2})/[2K_3^2(t) - 1]\beta_A\}$; where $\epsilon_{d0} = 2D_d eH_{c2}$, with D_d being the d-band diffusion coefficient; $\eta_d(H) = (e\tau_{t,rd}/m_d c)H$, which is the tangent of the Hall angle for a d band in the normal phase; and X(t) is a quantity of the order of unity. This relation explains qualita-

tively the experimental data for a dirty niobium superconductor reported by Niessen and Staas. (auth)

29467 ELECTRON–PHONON INTERACTION AND SUPERCONDUCTIVITY IN In–Tl ALLOYS. Taylor, D. W. (McMaster Univ., Hamilton, Ont.); Vashishta, P. Phys. Rev., B; 5: No. 11, 4410-20(1 Jun 1972).

The superconducting tunneling results obtained by Dynes for the electron–phonon part $\alpha^2(\omega)F(\omega)$ for indium–thallium alloys are examined in terms of both exact sum rules for alloy lattice dynamics and the self-consistent mass-defect theory. Detailed calculations are made of $\alpha^2(\omega)F(\omega)$ for four alloy concentrations. Good over-all agreement is found between calculated and tunneling-derived results. The analysis seems to support Dynes's conclusion that the phase transition in the alloy structure near 30-at.% thallium could be due to phonon-mode softening. Zero-temperature Eliashberg equations are solved using the calculated and tunneling-derived values of $\alpha^2(\omega)F(\omega)$ to determine the gap and renormalization functions. Reduction in the dc Josephson current and condensation energies from their BCS value are calculated. Transition temperatures for the alloys are also calculated using the two sets of $\alpha^2(\omega)F(\omega)$. The agreement with the experiment is satisfactory. (auth)

29468 PENETRATION DEPTH AND FLUX CREEP IN THIN SUPERCONDUCTING INDIUM FILMS. Anderson, Robert A.; Ginsberg, D. M. (Univ. of Illinois, Urbana). Phys. Rev., B; 5: No. 11, 4421-34(1 Jun 1972).

The absolute value of the penetration depth was measured in superconducting indium films. Applying a dc axial magnetic field to the exterior of a hollow superconducting thin-film cylinder, the ratio $\Delta H_i/\Delta H_0$ of the variation of the magnetic field penetrating into the interior region to the variation of the applied magnetic field was determined. Applied magnetic fields of small amplitude were used so that ΔH_i was linear in ΔH_0; a superconducting magnetometer was used to measure ΔH_i. Film thicknesses were between 95 and 160 Å, and the temperature range was from 1.3 K to the critical temperature near 4.0 K. From the actual penetration depths deduced from these measurements, which were performed on four samples, values of the London penetration depth at absolute zero $\lambda_L(0)$ were calculated to be in the range 397 ± 22 Å. This indicates that $\lambda_L(0)$ in thin films is larger than typical published measurements for bulk indium, in accordance with other evidence. Except for one sample and for temperature within about 0.3°K of the critical temperature, the data were fitted moderately well by the theoretical temperature dependence. Flux creep depending logarithmically on elapsed time was also observed for values of ΔH_0 sufficiently large to induce currents in the film exceeding the critical-state current. The temperature dependence of the logarithmic flux-creep rate was approximately that of the product of the critical current, the absolute temperature, and the square of the penetration depth over a wide range of temperatures. (auth)

29469 SUPERCONDUCTING TRANSITION TEMPERATURE, LATTICE INSTABILITY, AND ELECTRON-TO-ATOM RATIO IN TRANSITION-METAL BINARY SOLID SOLUTIONS. Collings, E. W.; Ho, J. C.; Jaffee, R. I. (Battelle Columbus Labs., Ohio). Phys. Rev., B; 5: No. 11, 4435-49(1 Jun 1972).

In a series of transition-metal binary alloys, as the average electron-to-atom ratio Z decreases from 6.0 to 4.0, the measured electronic-specific-heat coefficient γ, and with it the average Fermi density of states $n(E_F)$ rises to a maximum near Z = 4.4. From an analysis of the coupled results of low-temperature calorimetic and magnetic susceptibility measurements it has been shown in a previous paper that, at least for the Ti–Mo system, the maximum in average $n(E_F)$ was induced through the influence of submicroscopic metallurgical inhomogeneities (clustering and second-phase precipitation) present in the as-quenched $Z \lesssim 4.3$ material, and was not a property of the (hypothetical) single-phase bcc alloy. In addition, it was demonstrated that were it not for this precipitation, the effects of which became increasingly noticeable as Z decreased below about 4.3, $n(E_F)$ would otherwise increase monotonically as Z decreased from 6.0 to 4.0. In this paper, which is an extension of that work, the superconducting behavior of Ti–Mo is explored. The results of calorimetric measurements yield both a superconducting transition temperature T_c and a Debye temperature Θ_D which (through the elastic constants c_{ij}) may be related to lattice stability. Again, if we postulate the existence of single-phase bcc Ti–Mo alloys, in which precipitation for $Z \lesssim 4.3$ has been inhibited, a semiquantitative argument shows that T_c should also increase monotonically with decreasing Z. As a generalization of this result, it is suggested that in the well-known double-humped curve of T_c vs Z for transition-metal binary alloys the local maximum near Z = 4.4 is induced (or at least strongly contributed to) by microstructural effects, rather than being a property of single-phase bcc alloys. Finally, a connection is made between the superconducting behaviors of transition-metal binary alloys, which might be regarded as low-perturbation systems, and the tightly bound transition-metal–nontransition-metal intermetallic compounds for which the very opposite is true. The coupling parameter is lattice stability which decreases with decreasing Z, in the range under consideration, for both the alloys as well as the compounds. The increase of T_c with decreasing Z generally terminates at the edge of the regime of phase stability (e.g., at the low-concentration limit of the equilibrium single-phase bcc field, in the case of Ti–Mo alloys). (auth)

Equipment and Devices

Refer also to abstracts 28259, 28699–28701, 28718, 28719, 28723, 28725–28734, 28744, 28812, 28839, 28840, and 28844.

29470 (LBL-198) TRANSITION FROM BULK BEHAVIOR TO JOSEPHSON-JUNCTION LIKE BEHAVIOR IN SUPERCONDUCTING MICROBRIDGES. Song, Yeong-du (California Univ., Berkeley. Lawrence Berkeley Lab.). Nov 1971. Contract W-7405-eng-48. 72p. Dep. NTIS.

Thesis.

The behavior of superconducting microbridges was studied as a function of the temperature, size and impurity dependent coherence length ξ of the evaporated film and the bridge length L. When $L \ll \xi$ near the transition temperature T_c, the ac and dc supercurrents in the bridge have a Josephson-junction like behavior. When $L \gg \xi$, the bridge behaves like a bulk superconductor. Continuous transitions from the bulk behavior to a Josephson junction like behavior are observed as a function of L/ξ by varying the temperature or the mean free path. Experimental results of the temperature dependence of the critical current are very well explained by the one-dimensional model of Baratoff et al. The finite-voltage I–V characteristics are qualitatively analyzed by the lumped-circuit-parameter model. The microwave-power dependence of the height of the induced-current steps is in good agreement with the calculation in the limit where the bridge shows Josephson-junction-like behavior. (auth)

29471 TWO-CHANNEL CURRENT STABILIZER FOR SUPPLYING SUPERCONDUCTING MAGNETIC SYSTEMS. Bershadskii, I. G.; Neymark, V. M. Elektrotekhnika; No. 6, 16-18 (Jun 1971). (In Russian).

A unit is described for stabilizing direct current used for supplying superconducting solenoids. The current is stabilized in two different circuits with smooth variation within the 0 to 150-A limits and parallel switching of channels from 0 to 300 A. Current maintenance stability is better than 0.001% and the variable component for a current load of 150 amps does not exceed 0.02%. The following block diagrams are given: one channel of the current stabilizer, the regulating element, feedback amplifier, variable supply source, etc. The proposed circuitry can serve for making multichannel and more powerful (1000 A and higher) stabilizers. (JPRS)

29472 MECHANICAL SUPERCONDUCTING SWITCH FOR LOW TEMPERATURE INSTRUMENTATION. Siegwarth, J. D.; Sullivan, D. B. (Inst. for Basic Standards, Boulder, Colo.). Rev. Sci. Instrum.; 43: No. 1, 153-4(Jan 1972).

A switch requiring 13 contacts, all of which must be superconducting, is described. The design uses a wiping contact which needs to carry only 1 to 10 mA for the application. This switch provides a large safety margin as it handles ~3A per contact without reverting to the normal state. The switch remained reliable with thermal cycling and storage at room temperature for several weeks. The switch was cycled to liquid helium temperature about ten times and switched several hundred times with no appreciable wear of the contact surfaces. (M.H.R.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstract 30091.

29473 (DP-MS-71-28) FINITE DISCRETE FOURIER TRANSFORM SOLUTION TO THE NEUTRON DIFFUSION EQUATION. Hightower, Janie Loutricia (Vanderbilt Univ., Nashville, Tenn.). May 1971. 37p. Dep. NTIS.

The feasibility of using the Fast Fourier Transform in solving the neutron diffusion equation is investigated by calculating the neutron flux in a reactor and its behavior with the insertion of control rods. (8 figures, 2 tables) (R.W.R.)

29474 (LA-DC-13295) AUTOMATED METHOD TO CALCULATE NONFISSION NEUTRON AND NEUTRON-INDUCED GAMMA HEATING IN AIR AND OTHER MATERIALS FROM BASIC MULTIGROUP CROSS SECTION DATA. Sandmeier, Henry A.; Hansen, G. E.; Asprey, M. E. (Los Alamos Scientific Lab., N. Mex.). 25 Oct 1971. 8p. (CONF-711125-10). Dep. NTIS.

From Radiation Shielding Information Center seminar-workshop; Oak Ridge, Tenn. (15 Nov 1971).

An expression for computer calculation of the heating of air or weapons material due to a neutron flux and a gamma flux was obtained from a coupled neutron–gamma transport calculation. The neutron energy deposition requires the knowledge of individual neutron reaction cross sections: it is assumed that these data are available as a function of discrete energy points and in a group-averaged form. (R.W.R.)

29475 (UCRL-51144) LIVERMORE PULSED SPHERE PROGRAM: PROGRAM SUMMARY THROUGH JULY 1971. Wong, C.; Anderson, J. D.; Brown, P.; Hansen, L. F.; Kammerdiener, J. L.; Logan, C.; Pohl, B. (California Univ., Livermore. Lawrence Livermore Lab.). 4 Nov 1971. 40p. Dep. NTIS.

Neutron emission spectra for spherical targets bombarded with a centered, nominal 14-MeV neutron source were measured for many elements and compounds. These measurements provided checks on the neutron transport codes and the input neutron cross section information. This report describes in detail the experimental technique employed and presents the spectra measured through July 1971. (25 figures, 2 tables) (auth)

29476 METHODS OF BIASING SECONDARY GAMMA-RAY PRODUCTION IN COUPLED NEUTRON GAMMA-RAY MONTE CARLO CALCULATIONS. Solomito, Emilio Jr. Knoxville, Tenn.; Univ. of Tennessee (1971). 90p. University Microfilms Order No. 72-5489.

Thesis.

Methods for applying importance sampling techniques to secondary gamma-ray generation in coupled, neutron-gamma-ray Monte Carlo transport calculations have been developed and evaluated. The Boltzmann transport equation is presented in an integral-matrix form which defines a set of coupled neutron-gamma-ray, multigroup equations and provides the basis for the coupled Monte Carlo random walk. Three methods of biasing the production of secondary gamma rays which make use of important functions obtained from discrete ordinates adjoint calculations are formalized. These methods employ importance sampling techniques which include alteration of the gamma-ray generation probabilities, non-absorption weighting, and a combination of splitting and Russian roulette. These three methods are evaluated using the multigroup, Monte Carlo code MØRSE in the solution of a deep-penetration shielding problem in concrete. All three methods are shown to be more efficient than the standard method of biasing the secondary gamma-ray production in the MØRSE code. The methods varied from a factor of 1.3 to 40.0 better than the standard method based on the running time of the code and variance of the answer obtained. (Diss. Abstr. Int., B)

29477 PRODUCTION OF VERY COLD NEUTRONS. Golub, R. (Univ. of Sussex, Brighton, Eng.). Phys. Lett.; 38A: No. 3, 177-8(31 Jan 1972).

A method of calculating the current of very cold neutrons emerging from a cold moderator applicable to any moderator whose spectral density is known is presented. Results are shown for a hydrogenous moderator with a Debye spectrum. (auth)

29478 GENERALIZED EXACT SOLUTION OF THE SLOWING-DOWN EQUATION. Dawn, Trine-yie (National Tsing Hua Univ., Hsinchu, Taiwan). J. Nucl. Sci. Technol. (Tokyo); 9: No. 2, 93-6(Feb 1972).

The slowing down equation for an infinite homogeneous monoatomic medium is solved exactly. The solution is obtained in analytical form. The calculated collision density is compared with the one obtained by Teichmann and Stefanovi'c respectively. For the special case of hydrogen, the present solution reduces to Bethe's solution. (auth)

29479 HIGH-RESOLUTION VELOCITY SELECTOR FOR COLD NEUTRONS. Strigazzi, A.; Tartaglia, A. (Politecnico, Turin). Energ. Nucl. (Milan); 19: No. 1, 42-9(Jan 1972).

A two-rotor phased chopper system for cold neutrons is described. This system, spinning around a vertical axis at ~7,200 rpm, is designed to supply each round four bursts of monochromatic cold neutrons. Two solutions are considered: a) a twin-rotor system; and b) a system composed of two geometrically different rotors (one of them being the same as in the first solution). Both systems are designed to supply a neutron bunched beam of 10Å; however, the former allows an overall resolution of ~1%, with an average transmission probability of approximately 70%, while with the latter the values of ~0.75% and ~14% are obtainable respectively. (auth)

29480 PHASE SPACE TIME EVOLUTION METHOD. Tavel, Morton A. (Vassar Coll., Poughkeepsie, N. Y.); Zucker, Martin S. Transp. Theory Statist. Phys.; 1: No. 2, 115-43(1971).

A new computer method for solving problems of time dependent particle transport is presented and applied to the solution of several one-speed neutron transport problems having planar symmetry. The method employs the basic concept of conservation of points in phase space, enabling the computer to be used simply as a bookkeeping device to directly keep track of the locations of small phase space elements as they move in time. It is felt that this approach embodies a more direct and efficient use of the computer, as it eliminates the difficult, tedious and essentially intermediate step of writing down the time dependent transport equation and programming the computer to effect its solution. The actual program has been refined by the development of a digitized Green's function, which allows the time evolution of the neutron distributions to be generated by simple matrix multiplication. (auth)

29481 SOLUTION OF THE MONOENERGETIC NEUTRON BOLTZMANN EQUATION IN CYLINDRICAL GEOMETRY. Premuda, F. (CNEN, Bologna). Transp. Theory Statist. Phys.; 1: No. 4, 329-49(1971).

The F-transform Boltzmann equation for monoenergetic neutrons is derived, in the stationary case, for arbitrary three-dimensional geometries. After some general results, the F-transform equation, which is in order in the case of a homogeneous cylinder of infinite height in critical and subcritical conditions, is considered. A monodimensional linear integral equation for a function, which is related to the F-transform of the total non-virgin flux, is obtained and then proved to be of the Fredholm type. The solution of such an equation is cast into a series expansion, whose coefficients satisfy an infinite linear algebraic system. The vanishing of the determinant of such a system yields the criticality condition for the physical system under consideration. Finally the solution of the transformed equation is inverted to give the space-angular neutron flux distribution. (auth)

29482 NEUTRON FLUX DENSITY DISTRIBUTION AROUND THE NEUTRON GENERATOR TARGET. Janczyszyn, J.; Taczanowski, S. (Academy of Mining and Metallurgy, Krakow). Radiochem. Radioanal. Lett.; 9: No. 2, 143-5(30 Jan 1972).

A critical discussion of the NFD distribution around the neutron generator target is given. (auth)

29483 ANALYSIS OF COLD NEUTRON SPECTRA IN LOW TEMPERATURE SOLID. Utsuro, Masahiko (Kyoto Univ., Osaka). Nippon Genshiryoku Gakkai Rochuseishi Kenkyu Senmon Iinkai Hokoku; No. 32, 15-25(Feb 1971). (In Japanese).

By analyzing the general form of cold neutron spectra in low-temperature solids with a simple model for scattering cross section, an approximate formula for the spectra was introduced. The scattering cross section for moderation of the cold neutrons due to lattice vibration was studied with Debye model. The cold neutron spectra in a region of $E < k\Theta_v$ was analyzed, where Θ_v is Debye temperature of the solid. The approximate formula obtained for the cold neutron spectra was compared with experiment. The formula was in agreement with the experimental results in regions of gradient $E^{-1 \text{ to } 2.5}$ and gradient E. Information concerning properties of slowing down media may possibly be derived and this was studied

by analyzing directly the experimental spectra. A general formula of incoherent inelastic scattering of low-energy neutrons in the low temperature solid was obtained. Analysis was carried out for light water ice, and it was found that the properties of neutron scattering in the cold media can be studied by the direct analysis of cold neutron spectra. (Japan)

29484 APPLICATION OF SPACE-DEPENDENT MULTIGROUP THEORY TO THE ANALYSIS OF NEUTRON SLOWING DOWN TIME EXPERIMENTS. I. LIGHT AND HEAVY WATER MODERATORS. Beynon, T. D.; Mondal, M. A. W. (Univ. of Birmingham, Eng.). J. Phys., D (London); 4: No. 12, 1843-55 (Dec 1971).

A detailed study was made of some recent measurements by Moeller (1966) and Chen and Lidofsky (1967) of the most probable slowing down times of neutrons in light and heavy water. Using both an energy multigroup and a mixed-energy group-energy point technique, together with a moments-matching technique, the P1 and the diffusion approximations to the time-dependent Boltzmann equation are solved numerically. Good agreement was obtained with the spatially dependent results at 1.46-eV obtained by Moeller in light and heavy water. It is demonstrated that in order to reproduce the measurements of Chen and Lidofsky, made with a cadmium-shielded 1/v detector, it is necessary to allow for the energy dependence of the detector response. Generally, it is found that the P1 approximation reproduces these measurements better than the diffusion approximation. (auth)

29485 SUITABILITY OF MgO, SiO_2, AND Bi SINGLE OR QUASI-SINGLE CRYSTALS AS FILTERS FOR HIGH-INTENSITY SUBTHERMAL AND THERMAL NEUTRON BEAMS. Bauer, G.; Seyfarth, H. (Kernforschungsanlage, Juelich, Ger.). Atomkernenergie; 18: No. 3, 236-46(Nov 1971). (In German).

Experiments are described to determine the transmission rates of subthermal, thermal, epithermal, fast neutrons, and γ rays through quasi-single crystals of Bi (6, 12, 24 and 36 cm) and a single crystal of MgO (6 cm) at 293 and 77°K. Time-of-flight measurements in the subthermal and thermal energy region, activation of an 1/v absorber (gold) in the thermal and epithermal energy region and the reaction $^{31}P(n,p)^{31}Si$ in the fast energy region were used to determine neutron transmission rates. Discrepancies of γ transmission rates determined with different ionization chambers are discussed. Plots are presented to show the variation of the neutron spectrum, the shift of the mean neutron wavelength with filter length and temperature, and the neutron current density, referring to a standard geometry. This may be helpful in designing new filter set-ups. Transmission rates of various filter types and lengths at different temperatures were compiled, using also results of several other authors. Comparison with calculation was found to yield satisfactory agreement in most cases. (auth)

29486 PULSE DIE-AWAY EXPERIMENT IN SMALL GRAPHITE PRISMS WITH THE COLD NEUTRON SOURCE. Takahashi, kito; Ishijima, Kiyomi (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 9: No. 1, 60-4(Jan 1972).

In contrast to experiments with fast neutron sources, decay constants for small graphite prisms were found to approach the Bragg peak values when a thermalized pulsed source was used. The pulsed cold neutrons were produced by the moderation of pulsed fast neutrons in a 77°K methyl alcohol layer. Measurements were also made for an epithermal source for comparison. (J.W.R.)

29487 EXAMINATION OF NEUTRON DIFFUSION THEORY FOR MEDIA CONSISTING OF LATTICES OF LARGE CROSS-SECTION CAVITIES. Zhezherun, I. F. At. Energ. (USSR); 32: No. 2, 143-52(Feb 1972). (In Russian).

The diffusion of thermal neutrons in several anisotropic media has been studied using pulsed neutron techniques. The media consisted of lattices of square cross-section hollow cavities in beryllia and beryllium. The transverse dimensions of the cavities exceeded the free transport path. A correction due to the finite length of the cavities was taken into account in calculating the diffusion coefficient from the experimental data. The longitudinal and transversal diffusion coefficients obtained agree with the theoretical values. Taking the above correction into account in other published experimental results, including cases of lattices of large-diameter cavities, also leads to close agreement with theoretical predictions. (auth)

Nuclear Properties and Reactions, A ≤ 5

Refer also to abstracts 29232, 29304, 29517, 29590, 29727, 29764, and 29775.

29488 (AD-734876) SCATTERING OF POLARIZED 3-MeV NEUTRONS FROM ^{3}He. Hollandsworth, C. E.; Gilpatrick, M.; Bucher, W. P. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Nov 1971. 23p. NTIS.

Partially polarized 3-MeV neutrons have been scattered from ^{3}He contained in a high-pressure gaseous scintillation cell. The resulting asymmetry in the elastic scattering was determined for seven scattering angles from 40 degrees to 120 degrees (lab). Time-of-flight techniques and neutron-gamma ray discrimination in the side detectors were used for background reduction. The measured asymmetry is small for angles less than 60 degrees (lab) and reaches a maximum value at approximately 110 degrees (c.m.). The maximum asymmetry determined from the present experiment corresponds to a polarization of +0.50. The differential polarization can be fitted within experimental uncertainties by assuming that D-wave effects are negligible. The principal features of the data are qualitatively reproduced by Dodder's reaction-matrix calculations which use the Werntz–Meyerhof level parameters for ^{4}He. (auth) (NTIS)

29489 (FRNC-TH-161) ELASTIC n-^{8}Li SCATTERING. Remaud, Bernard (Nantes Univ. (France). Faculte des Sciences). 1971. 138p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

This investigation was carried out in the framework of the Wheeler resonance group model in view of developing methods for extending the theoretical study of nuclear collisions for $4 \leq A \leq 16$ nuclei. The space functions of $A \leq 8$ nuclei are calculated from the shell model. A Gaussian two-body potential is used to study nucleon-nucleon interactions. Total wave functions (with L-S coupling) are obtained by antisymmetrizing for all the nucleon pairs. The binding energy of the ^{8}Li nucleus is calculated in the framework of the group resonance model using an α particle and a deuteron as the basic configuration. The results obtained are in good agreement with the experimental data. The n-^{8}Li elastic collision equation is developed and the cross sections are calculated in the framework of the group resonance structure. The order of magnitude of the differential cross sections corresponding to the elastic scattering is confirmed in the 5- to 15-MeV energy range in spite of the approximations made (single channel reaction, central Gaussian potential). (France)

29490 (NP-19216) HYPERSPHERICAL-EXPANSION APPROACH TO NUCLEAR BOUND STATES. IV. THE LIMIT OF LARGE A FOR VELOCITY-DEPENDENT POTENTIALS. Note No. 313. Calogero, F.; D'Andrea, A.; Olivieri, E.; Ragnisco, O.; Scalia, M.; Simonov, Yu. A.; Surkov, E. L. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 17 Apr 1971. 53p. Dep. NTIS (U. S. Sales Only).

The first approximation of the hyperspherical-expansion approach to nuclear bound states is discussed in the limit of large A. For velocity-independent potentials, the results given in a previous paper are rederived in a more explicit and straightforward fashion, and a more complete discussion of the next-to-leading terms in the asymptotic formula for the binding energy is given. For velocity-dependent potentials similar results are obtained. The density distribution that results from this treatment is exhibited and discussed. A comparison with the analogous formula for the binding energy per nucleon that obtains in the Fermi gas treatment of nuclear matter is made, including the presentation of numerical results for the potential of Nestor, Davies, Krieger and Baranger. (1 figure, 1 table) (auth)

29491 PRECISION n–p TOTAL CROSS-SECTION MEASUREMENT AT 526.0 keV. Simmons, David Frank. Charlottesville, Va.; Univ. of Virginia (1971). 128p. University Microfilms Order No. 72-7250.

Thesis.

A value for σ_{np} of 5.956 b ± 0.24% was measured at a mean neutron energy of 526.0 ± 1.3 keV. This corresponds to singlet effective range of 2.95 ± 0.12 F using the most recent effective range theory parameters. The result is within two standard deviations of the charge-independent prediction of 2.73 ± 0.03 F. The result agrees well with previous total cross-section measurements made 1952-1954 using the adjusted energies of Davis and Barschall r_s = 2.91 ± 0.09 F. Agreement with the measurement of Engelke et al., at 0.4925 MeV is not as good, r_s = 2.66 ± 0.09 F. Time-of-flight methods made possible a high signal-to-background ratio with high counting rate in the determination of transmissions (T = 0.42 and T = 0.48) of a pure hydrogen sample. The in-scattering correction was + 0.31%. Timing techniques were also used to measure neutron energy. It is concluded that further measurements below 5 MeV are necessary to verify charge independence to within the accuracy of that prediction and to resolve the apparent systematic differences in the total cross section data. The techniques employed here offer several avenues for improvement. (Diss. Abstr. Int., B)

29492 SEARCH FOR ^{4}H PRODUCED BY THE CAPTURE OF NEGATIVE PIONS IN LITHIUM, A = 6. Grubb III, William Franklin. Charlottesville, Va.; Univ. of Virginia (1971). 106p. University Microfilms Order No. 72-7289.

Thesis.

A search was made for the ground and excited states of ^{4}H reported by Cohen et al., and Minehart et al., to be formed in the reaction ^{6}Li (π^-, ^{2}H) ^{4}H. The three-body phase space energy distribution for the deuterons of the above reaction was shown to exhibit a peak as a function of opening angle, θ, in the same kinematical region, θ = 0.175 radians, as the previously reported ground state of ^{4}H. No other structure appeared in the data at larger values of opening angle which could represent the previously reported excited states of ^{4}H. Data for the energy distribution of the tritons from the reaction ^{6}Li (π^-, ^{2}H) ^{3}H + n were also obtained. An attempt was made to use these triton data to obtain a value for the three-body phase space normalization constant for the deuteron data which represented the ground state of ^{4}H, so that the data associated with pure phase space could be eliminated. However, the three-body phase space normalization constant obtained from a least squares fit of the triton data was 2.5 times as large as the value obtained from a least squares fit of the deuteron data to the phase space energy distribution. Since both the triton and the deuteron data were fit to an empirical function which accounted for contributions of other possible particles, no explanation could be found for this discrepancy. All other values of the phase space normalization obtained from other values of opening angle indicated that the data could be represented by phase space distributions alone. The data of Cohen et al., and Minehart et al., were examined and it was found that both sets of data were compatible with the energy distributions expected from phase space. (Diss. Abstr. Int., B)

29493 STUDY OF THE ^{2}H(d,n)^{3}He REACTION BETWEEN 12 AND 19 MeV. Dietrich, F. S. (Stanford Univ., Calif. Univ. of California, Livermore); Adelberger, E. G.; Meyerhof, W. E. Nucl. Phys.; A184: No. 2, 449-57(1972).

The ^{2}H(d,n)^{3}He reaction was studied at incident energies from 12 to 19 MeV, using a neutron time-of-flight spectrometer. Angular distributions of the discrete neutron group were determined, and the c.m. distributions were fitted with a series of even Legendre polynomials in the form $d\sigma/d\Omega = \Sigma_0^{12} A_L P_L(\cos\theta)$. The coefficients A_L were normalized to and compared with other literature values. If the main energy dependence, which lies in penetrability functions, is removed from the coefficients, they show only little energy variation above 2 MeV, which suggests that the reaction is dominated by direct processes. Only in the L = 4 coefficient a broad feature occurs which may indicate strong d-wave effects in the ^{4}He system near 30 MeV excitation energy. The continuum spectra at 0° from the ^{2}H(d,n)^{3}He reaction exhibit a smooth variation with incident energy and show no evidence for a virtual state in ^{3}He below 15 MeV excitation energy. (auth)

29494 CALCULATION FOR p-^{3}H AND n-^{3}He S-MATRIX ELEMENTS. Heiss, P.; Hackenbroich, H. H. (Univ., Cologne). Z. Phys.; 251: No. 2, 168-72(1972).

Starting from nucleon-nucleon forces containing spin-orbit and tensor parts p-^{3}H and n-^{3}He S-matrix elements are calculated; all possible couplings of p-^{3}H and n-^{3}He channels are considered. The results are discussed and compared to a preliminary experimental phase shift analysis. (auth)

29495 CHARGE SYMMETRY IN THE MIRROR REACTIONS ^{3}H(d,^{3}He)2n AND ^{3}He(d,t)2p AT 83 MeV. Bachelier, D.; Bernas, M.; Harney, H. L.; (and others) (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A184: No. 2, 641-57(1972).

The nn and pp final-state interaction spectra were measured at 2.5 and 7.5° in the mirror reactions ^{3}H(d,^{3}He)2n and ^{3}He(d,t)2p at 83 MeV deuteron energy. The Watson-Migdal treatment does not give a good description of these spectra. Application of the comparison method of Slobodrian et al. gives a mean value for a_{nn} of −15.5 fm, and very large values for r_{0n}; the variation of the production form factor with the relative energy of the two nucleons seems also very large. The coherent addition of a constant amplitude to the Watson-Migdal amplitude introduces only a limited number of parameters: this method gives for r_{on} a mean value of 3.3 fm, but the values found for a_{nn} (around −12 fm) are in general smaller than the theoretical predictions. A more rigorous theoretical treatment of these deuteron induced reactions seems necessary. Measurements were also performed on the mirror reactions ^{3}H(d,t)pn, ^{3}He(d,^{3}He)pn and ^{3}H(d,t)^{3}H, ^{3}He(d,^{3}He)^{3}H. (auth)

29496 STUDY OF EXCITED STATES OF ^{5}He BY THE ^{7}Li (d,α)^{5}He REACTION. Strauss, L.; Friedland, E. (Univ. of Pretoria). Z. Phys.; 250: No. 5, 370-8(1972).

The interactions of deuterons with ^{7}Li, in which two α-particles and a neutron are produced in the final state, were studied at E_d = 1.2 MeV. The dual parameter $\alpha-\alpha$ coincidence spectrum was analyzed with a search program. The results indicate two excited states of ^{5}He: one at excitation energy 2.9 ± 0.1 MeV with a reduced width of γ^2 = 1.1 ± 0.4 MeV and the other at 4.8 ± 0.4 MeV with γ^2 = 0.9 ± 0.4 MeV. No contributions of sequential decay through the 4^+ state in ^{8}Be or direct three-body decay was observed. (3 figures) (auth)

29497 PHASE SHIFTS FOR p-^{4}He ELASTIC SCATTERING BETWEEN 20 AND 40 MeV. Plattner, G. R. (Univ., Basel); Bacher, A. D.; Conzett, H. E. Phys. Rev., C; 5: No. 4, 1158-68 (Apr 1972).

A phase-shift analysis of recent p-^{4}He cross-section and polarization data was performed between 20 and 40 MeV proton laboratory energy. A set of single-energy results is presented which shows little scatter as a function of energy. The match between these results and existing phase-shift sets below 20 and above 40 MeV is excellent. The most striking feature of the phase shifts above the inelastic threshold at 23.02 MeV is the dominance of absorption in the even partial waves. There is weak evidence in the energy dependence of the phase shifts for levels of ^{5}Li other than the well-known $\frac{3}{2}^+$ second excited state. Tentative assignments of spin and parity of such levels are discussed. An R-matrix parametrization of the $^2D_{\frac{5}{2}}$ phase shift was performed over the p-^{4}He resonance corresponding to the second excited state of ^{5}Li, and improved level parameters are presented for this state. (8 figures, 2 tables, 46 references) (auth)

29498 POLARIZATION AND CROSS-SECTION MEASUREMENTS FOR p-^{4}He ELASTIC SCATTERING BETWEEN 20 AND 45 MeV. Bacher, A. D.; Plattner, G. R.; Conzett, H. E.; (and others) (Univ. of California, Berkeley). Phys. Rev., C; 5: No. 4, 1147-57(Apr 1972).

Angular distributions of the polarization and the cross section for p-^{4}He elastic scattering were measured in 2-MeV steps between 20 and 45 MeV and in steps of approximately 150 keV across the 23.4-MeV resonance corresponding to the second excited state of ^{5}Li at 16.7 MeV excitation. The relative uncertainties of the polarization measurements are typically less than ±0.01. The normalization uncertainty from energy to energy and relative to the older data below 20 MeV proton energy is approximately 2%. The cross-section angular distributions with a relative uncertainty of 3% were normalized to previously existing data, since an absolute cross-section measurement was not feasible with the experimental setup. The polarization measurements provide an accurate proton polarization analyzer up to 45 MeV. With the exception of the narrow resonance region around 23.4 MeV, the analyzing power near θ_{lab} = 125° exceeds 80% at all energies and shows no rapid variations. Around 30 MeV, a very weak and broad anomaly, coinciding in ^{5}Li excitation (approximately 22 MeV) with the structure observed in d-^{3}He elastic scattering is seen in the polarization. (5 figures, 6 tables) (auth)

29499 STUDY OF THE n-n INTERACTION FROM A COMPLETE EXPERIMENT OF THE n + d BREAK-UP AT 14.5 MeV. Bouchez, R.; (CEN, Grenoble, France); Desreumaux, S.; Gondrand, J. C.; (and others). Nucl. Phys.; A185: No. 1, 166-76 (1972).

Results of the analysis of two complete experiments on ^{2}H(n,nnp) at 14.5 ± 0.1 MeV are given. In the first n-n final-state-interaction (f.s.i.) experiment (neutron lab angles $\theta_1 = \theta_2 = +30°$, n-n relative energy E_{nn} measured between 0 and ≈ 800 keV) about 4400 events were recorded. In the second n-p f.s.i. experiment (neutron lab angles $\theta_1 = +30°$, $\theta_2 = -80°$, and $E_{np} \lesssim 500$ keV) about 2860 events were recorded. The analysis has been done by exact solutions of the Faddeev equations with separable potentials: the Amado model was extended using the Yamaguchi potential with charge-independent ($a_{nn} = a_{np}$) and with charge-dependent ($a_{nn} = -16$ fm, $a_{np} = -23.7$ fm) parameters. The results are: (a) the charge-independent ($a_{nn} = -23.7$ fm) model seems to give a better fit for the shape of the n-n f.s.i. peak, but (b) the two-nucleon separable potential calculations disagree by a factor ≈ 2 with the absolute cross sections measured for the f.s.i. peaks. (auth)

29500 MEASUREMENTS OF ^{3}H(p,n)^{3}He NEUTRON POLARIZATIONS FOR E_p = 1.5 to 5.0 MeV. Smith, J. R.; Thornton, S. T. (Univ. of Virginia, Charlottesville). Nucl. Phys.; A186: No. 1, 161-70(1972).

Using neutron time-of-flight techniques and a liquid-helium polarization analyzer, eleven neutron polarization angular distributions ($P(\theta)$) have been measured for ^{3}H(p,$\vec{n}$)^{3}He for proton energies from 1.50 to 5.00 MeV. Using Legendre polynominal expansions of $\sigma(\theta)$ and $P(\theta)\sigma(\theta)$, values of $P(\theta)$ and $P^2(\theta)\sigma(\theta)$ were calculated, and a contour map of $P(\theta)$ was produced for the energy range 1.5 to 5.0 MeV. (auth)

29501 FINAL-STATE INTERACTIONS IN THE BREAK-UP REACTION OF DEUTERONS BY NUCLEONS. Takeutchi, F. (Tokyo Univ.); Sakamoto, Y. Nucl. Phys.; A185: No. 2, 366-84 (1972).

The nucleon-nucleon correlation spectra of the cross sections for the break-up reaction of deuterons by nucleons are calculated taking account of final-state interactions between nucleons in pairs. The higher partial waves in the interactions and the D-state wave function of deuterons are included. The partial waves are obtained by solving the Schroedinger equations with the Hamada-Johnston potential for two-body scattering states. The results are compared with experimental data for 198, 156, 100, 46, 45, 23 and 17 MeV incident protons. (auth)

29502 EXPERIMENTS WITH POLARIZED NEUTRONS FROM THE D(d,n)^{3}He REACTION. Haensgen, H. (Technische Univ., Dresden). Kernenergie; 14: No. 10, 341-3(Oct 1971). (In German).

Inexact knowledge of the degree of polarization of neutrons from D(d,n)^{3}He reaction so far hindered evaluation of experiments performed with them. The present paper aims at both clearing up the degree of polarization of neutrons emitted and precising information about polarizing power of some nuclei by critical analysis of the full material published on polarization in the D(d,n)^{3}He reaction for deuteron energies below 2 MeV. (auth)

29503 POLARIZATION DIFFERENCES IN THE REACTIONS D(d,p)T AND D(d,n)^{3}He AND CHARGE SYMMETRY. Hardekopf, R. A. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.); Walter, R. L.; Clegg, T. B. Phys. Rev. Lett.; 28: No. 12, 760-3(20 Mar 1972).

Accurate measurements have been made of the analyzing power for the reaction T(p,d)D which are equivalent to proton polarizations from D(d,p)T. If allowance is made for the reaction Q-value difference between D(d,p)T and D(d,n)^{3}He, thus comparing the data at the same outgoing neutron and proton energies, the polarizations are identical. This agreement eliminates much of the concern about charge-symmetry violation in the d + d reactions. (auth)

29504 DISTORTED WAVE IMPULSE APPROXIMATION FOR THE BREAKUP OF DEUTERONS. Bassel, Robert H.; Langworthy, James B. (Naval Research Lab., Washington, D. C.). Particles Nucl.; 2: No. 6, 369-75(Dec 1971).

The distorted-wave approach improves on simple impulse approximation by allowing for the loss of flux from the elastic channel to the breakup channel. This introduces absorption factors, which reduce the cross section magnitude for better agreement with experiment. This calculation evaluates at 14.1 MeV under quasi-elastic equal-angle conditions. The results show a large improvement in the ratio of the two breakup modes. (2 tables) (auth)

29505 HIGH-LUMINOSITY, HIGH-RESOLUTION STUDY OF THE END-POINT BEHAVIOR OF THE TRITIUM β-SPECTRUM. II. THE END-POINT ENERGY OF THE SPECTRUM. COMPARISON OF THE EXPERIMENTAL AXIAL-VECTOR MATRIX ELEMENT WITH PREDICTIONS BASED ON PCAC. Bergkvist, Karl-Erik (Univ. of Stockholm). Nucl. Phys.; B39: No. 1, 371-406(1972).

An evaluation of the end-point energy of the tritium β-spectrum is described. The experimental data employed are basically identical with those involved in a previous paper concerned with an inspection of the end-point region of the tritium β-spectrum for evidence of neutrino mass and neutrino degeneracy. By using combined electrostatic and magnetic β-spectroscopic methods, allowing an improvement in luminosity of about three orders of magnitude, a much more detailed exploration of the end-point behavior of the tritium spectrum than previously possible was achieved in that paper. The improved accuracy in the experimental data on the shape of the spectrum in the end-point region also forms a favorable starting point for the realization of an improved accuracy in the determination of the magnitude of the end-point energy. The initial error in the end-point energy, expressing the purely statistical uncertainty in the fitting of the straight line in the Kurie plot, is ±2 eV. The present paper is essentially concerned with the analysis and experimental measures required for retaining as much as possible of the initial accuracy in the extrapolated end-point energy in the final statement about the magnitude of this entity. The result arrived at for the end-point energy of the tritium spectrum is $E_{\beta,\max}$ = 18.610 ± 0.016 keV. Several other measurements, of about five times smaller accuracy, are compatible with this value. The result refers to the end-point energy of the spectrum from the free tritium atom. The magnitude stated implies a value of 529.562 ± 0.017 keV for the ^{3}H-^{3}He nuclear mass difference and a value of 18.651 ± 0.016 keV for the ^{3}H-^{3}He atomic mass difference. The inferred ft-value for the tritium decay becomes 1148 ± 3 sec, from which a value $|M_A|^2 = 2.91 \pm 0.05$ can be established. Writing $|M_A|^2 = |M_A^0|^2(1+\delta)^2$, where M_A^0 is the theoretical axial-vector matrix element disregarding exchange effects, this experimental value of $|M_A|^2$ implies a positive value on the exchange parameter δ, preserving the discrepancy between experiment and the calculations by Blin-Stoyle and Tint previously pointed out by these authors. The present experimental result for δ implies agreement to within roughly a one-percent accuracy with recent calculations by Blomqvist, taking one-pion exchange processes into account. Because of a certain covariance between the resulting experimental and theoretical values of δ this agreement can be claimed essentially irrespective of the uncertainty in the structure of the triton. (auth)

29506 NEUTRON SPECTRUM AND ASYMMETRY OF THE ANGULAR DISTRIBUTION IN MUON CAPTURE ON ^{4}He NUCLEUS. Eramzhyan, R. A.; Fetisov, V. N.; Salganic, Yu. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys.; B39: No. 1, 216-26(1972).

The neutron channel in muon capture by ^{4}He is considered. The dependence of the energy spectrum and asymmetry of the angular distribution in the reaction $\mu^- + {}^4\text{He} \rightarrow {}^3\text{H} + n + \nu$ on relativistic terms of the muon-nucleon Hamiltonian and final state interaction is investigated. It is shown that the above mentioned factors are decisive in the description of the high energy part of the spectrum and asymmetry. (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 28863, 29169, 29475, 29492, 29552, 29554, 29560, 29564, 29573, 29580, 29590, 29727, 29761, 29773, 29774, 29826, 29828, and 29829.

29507 (AD-734877) SMALL-ANGLE ELASTIC SCATTERING OF 7.55- AND 9.50-MeV NEUTRONS FROM C, N, AND O. Bucher, William P.; Hollandsworth, Clinton E.; Lamoreaux, Richard D.; Niiler, Andrus; Sankey, Richard R. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Nov 1971. 41p. (BRL-1562). NTIS.

The calculation of neutron transport in air requires an accurate knowledge of the neutron cross sections for nitrogen and oxygen. Existing direct measurements of the total elastic cross section for nitrogen in the energy range from 6 to 10 MeV are in marked disagreement with the value deduced by taking the difference between the total cross section and the sum of all partial nonelastic cross sections. This discrepancy in the data previously available indicates an error in the total elastic measurement of approximately 30 percent or a 50 percent error in the total nonelastic cross section. A technique to measure differential cross sections for the small-angle (2 degrees to 15 degrees) scattering of fast neutrons has been developed and applied to a study of the scattering of 7.55 and 9.50 MeV neutrons from C, N, and O. The results obtained for nitrogen at 7.55 MeV yield differential cross sections 20 percent to 40 percent higher (at forward angles) than would be inferred from previous measurements and shows that at least 25 percent of the missing cross section should be assigned to the total elastic cross section. (auth)

29508 (ANU-P-523) ENERGY LEVELS OF ^{16}O IN THE REGION OF EXCITATION BETWEEN 13.5 AND 15.0 MeV. Ophel, T. R.; Martin, Ph.; Cloud, S. D.; Morris, J. M. (Australian National Univ., Canberra. Research School of Physical Sciences). [1971]. 34p. Dep. NTIS (U. S. Sales Only).

Measurements were made of the $^{12}C(\alpha,\alpha_0)$, $^{12}C(\alpha,\alpha')$, $^{12}C(\alpha,\alpha'\gamma)$ and $^{12}C(\alpha,p)$ reactions for bombarding energies between E_α = 8.5 and 10.5 MeV. Phase shift analysis of the elastic scattering angular distributions and excitation functions complemented by particle and gamma ray angular distributions and Doppler-broadened profile measurements of the $^{12}C(\alpha,\alpha'\gamma)$ reaction enabled level assignments in ^{16}O. A complete description of the levels in the region of excitation studied was not possible because of the strong interference effects which were present. (auth)

29509 (ANU-P-531) CROSS-SECTIONS OF $^{10}B(\tau,\gamma)^{13}N$ AND $^{10}B(\tau,p\gamma)^{12}C$ REACTIONS. Bell, R. A. I.; Graham, I. G.; Thompson, J. V. (Australian National Univ., Canberra. Dept. of Nuclear Physics). [1970]. 17p. Dep. NTIS (U. S. Sales Only).

The differential cross sections of the $^{10}B(\tau,\gamma_0)^{13}N$, $^{10}B(\tau,\gamma_{3.5})^{13}N$, $^{10}B(\tau,p_{12.71}\gamma)^{12}C$, and $^{10}B(\tau,p_{15.11}\gamma)^{12}C$ reactions have been measured at 90° for beam energies corresponding to ^{13}N excitations between 25 and 35 MeV, using a large NaI crystal spectrometer. The be-

havior of the cross sections, and the smallness of the (τ,γ_0) cross section suggest that resonances reported in various $^{10}B(\tau,particle)$ channels between these excitations are not associated with the ^{13}N giant dipole resonances. (auth)

29510 (FRNC-TH-143) THEORETICAL AND EXPERIMENTAL STUDY OF ELECTROMAGNETIC TRANSITIONS. APPLICATION TO ^{8}Li AND ^{27}Mg. Costa, Gilles (Strasbourg Univ. (France)). 1971. 115p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A detailed theoretical and experimental investigation of the properties of electromagnetic transitions in ^{8}Li and ^{27}Mg enabled the validity of the models proposed to be verified. Measurements of γ-particle angular correlations and the angular γ distribution allowed a ($J^{\pi} = 1^{+}$) angular momentum and parity to be associated with the first excited level of ^{8}Li, this assignation being in agreement with predictions of the intermediate coupling model. The value obtained for the lifetime of this level demonstrates an acceleration of 2.5 in the M1 transition in relation to estimations made using the shell model with a single independent particle. The deformed nuclei region was studied in the case of ^{27}Mg, the Nilsson model being used. $\gamma\gamma$ angular correlation measurements and γ distributions enabled the mixing coefficients of transitions at 984 keV and 955 keV to be determined. The angular momenta of levels at 3109 and 3762 keV were studied and the lifetimes of 7 excited levels were determined using the Doppler effect. The structure of the ^{27}Mg nucleus is given by the Nilsson model for a positive deformation n = 2.5, levels above 3 MeV being explained by significant mixing effects in the rotation bands. (auth)

29511 (FRNC-TH-154) EXPERIMENTAL STUDY OF CERTAIN EXCITED LEVELS OF ^{12}B, ^{13}C, AND ^{19}O NUCLEI: CONSIDERATIONS OF CONFIGURATION MIXING AND RESIDUAL INTERACTION. Hibou, Francois (Strasbourg Univ. (France)). 1971. 120p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Certain excited levels of ^{12}B, ^{13}C, and ^{19}O nuclei were studied experimentally. The angular distributions of the protons produced by (d,p) reactions were measured using a wide band magnetic spectrograph; the results are analyzed using the DWBA method. The branching ratios were determined by γ^{-} particle coincidences and the lifetimes were measured by Doppler effect attenuation. The angular momenta of the neutron capture of the first 4 excited levels of ^{12}B and the partial widths of the nonbound levels of ^{13}C were determined. The multipolarity values of the γ transitions were determined for three ^{19}O levels. The branching ratios were obtained for 6 levels. The experimental results are compared with various theoretical results. The effect of the choice of configuration space is discussed together with a method of determining the residual interaction. (auth) (France)

29512 (LYCEN-7160) COMPARISON OF $(\alpha,2\alpha)$ AND $(\alpha,\alpha t)$ REACTIONS WITH ^{19}F AT 60.2 MeV. Chevallier, M.; Gaillard, P.; Grossiord, J. Y.; Gusakow, M.; Pizzi, J. R.; Ruhla, C. (Lyon Univ. (France). Institut de Physique Nucleaire). Sep 1971. 15p. (In French). Dep. NTIS (U. S. Sales Only).

The $(\alpha,2\alpha)$ and $(\alpha,\alpha t)$ reactions on ^{19}F have been studied at 60.2 MeV in order to compare the alpha and triton clustering probabilities in ^{19}F. These reactions, supposed to be produced by a quasi elastic scattering mechanism, were analyzed in PWIA. (France)

29513 (ORNL-TM-3702) GAMMA-RAY-PRODUCTION CROSS SECTIONS OF TANTALUM AND CARBON FOR INCIDENT NEUTRON ENERGIES BETWEEN 0.007 AND 20.0 MeV. Morgan, G. L.; Love, T. A.; Dickens, J. K.; Perey, F. G. (Oak Ridge National Lab., Tenn.). 8 Feb 1972. 72p. Dep. NTIS.

Cross sections for neutron induced gamma radiation from tantalum have been measured as a function of both neutron and gamma-ray energy. Neutron energies ranged from 0.007 to 20.0 MeV while gamma-ray energies from 1.0 to 10.5 MeV were measured. Data were taken at angles of 90° and 125° with respect to the incident neutrons. Similar measurements were made for natural carbon and these results demonstrate the efficacy of the data acquisition and reduction systems. (auth)

29514 STUDY OF THE (^{3}He,n) REACTION AT 25 MeV. Greenfield, Mark Bentley. Knoxville, Tenn.; Univ. of Tennessee (1971). 141p. University Microfilms Order No. 72-5443.

Thesis.

Energy spectra of neutrons from the $^{12}C(^{3}He,n)^{14}O$; $^{27}Al(^{3}He,n)^{29}P$; $^{28}Si(^{3}He,n)^{30}S$; and $^{58,60,62}Ni(^{3}He,n)^{60,62,64}Zn$ reactions have been measured at 25 MeV incident ^{3}He energy using time-of-flight techniques. An overall energy resolution of about 1 percent for detection of 10-35 MeV neutrons provided accurate determinations of level excitations. Differential cross sections were extracted for many two particle states with up to 10 MeV excitation in the residual nuclei. By varying the beam incident angle and leaving the flight path somewhat fixed, angular distributions from 0 to 35° lab were obtained. Making use of heavy shielding, neutron-gamma discrimination techniques and a cosmic ray anti-coincidence detector, background was reduced to the extent that cross sections on the order of 50 microbarn/sr could be measured. The shapes and relative magnitudes of the experimental angular distributions were compared with the theoretical predictions of distorted wave calculations, thus yielding orbital angular momentum (ΔL) transfers. Certain simplifying but well verified assumptions about the reaction mechanism enabled assignments of definite J^{π} values from the orbital angular momentum transfer values which best fit the shapes of the angular distributions. In some cases sensitivity of the calculations, mostly in magnitude, to the choice of bound state wave functions permitted determinations of the dominant two particle shell configurations of the final states. (Diss. Abstr. Int., B)

29515 EFFECT OF THE GIANT RESONANCE ON THE ENERGY SPECTRA OF NEUTRONS EMITTED FOLLOWING MUON CAPTURE ON ^{12}C AND ^{16}O. Plett, Michael Ellis. Charlottesville, Va.; Univ. of Virginia (1971). 117p. University Microfilms Order No. 72-7196.

Thesis.

The spectra of neutrons emitted following muon capture in carbon and oxygen are presented with a resolution of 6.5% at 5 MeV and a precision of 5%. The carbon spectrum is dominated by a broad peak at 4.2 MeV while the oxygen spectrum is dominated by a narrower peak at 5.1 MeV. Partial transition rates for these two peaks are given. This structure confirms the role of the giant resonance in the capture process. (Diss. Abstr. Int., B)

29516 VECTOR ANALYSING POWER OF (d,p) REACTIONS ON ^{16}O AND ^{24}Mg AT 12 MeV. Brown, R. C.; Govil, I.; Griffith, J. A. R.; (and others) (Univ. of Birmingham, Eng.). Nucl. Phys.; A185: No. 1, 49-57(1972).

Angular distributions of the vector analyzing power of (d,p) reactions on ^{16}O and ^{24}Mg were measured at $E_d = 12.3$ MeV. Transitions to the first two states of ^{17}O and to states up to 2.57 MeV excitation energy in ^{25}Mg were studied including the non-stripping reaction $^{24}Mg(d,p)^{25}Mg^{*}_{1.61}$. A comparison was made with the results of DWBA calculations. An attempt was made to take into account collective properties of the magnesium nuclei. (auth)

29517 COULOMB INTERFERENCE IN PROTON-NUCLEUS SCATTERING AT 144 MeV. Jarvis, O. N. (Atomic Energy Research Establishment, Harwell, Eng.); Whitehead, C.; Shah, M. Nucl. Phys.; A184: No. 2, 615-40(1972).

Differential cross-section data were obtained for the scattering of 144-MeV protons from ^{2}H, ^{4}He, ^{6}Li, ^{7}Li, and ^{12}C at small angles. These data were used in a study of the interference between Coulomb and nuclear scattering, using the basic nucleon-nucleon scattering amplitudes derived from phase-shift analyses as a starting point for the calculations. Both BA and WKB calculations described the deuterium data very well, but failed for the heavier nuclei. The optical potential of Kerman, McManus, and Thaler was integrated numerically in the Schrödinger equation and the predictions were compared with the proton cross-section data and with polarization data taken from the literature. This approach provided a good fit to the cross sections only for ^{7}Li. The optical-potential parameters were then adjusted to optimize the fits to the proton data and the final parameters were related back to the nucleon-nucleon amplitudes; a disagreement with the results of a previous analysis is noted. (auth)

29518 NEUTRON-PROTON CORRELATIONS FOR THE REACTION $^{12}C(d,n)^{13}N^{*}(p)^{12}C$. Valley, J. F.; Lang, J.; Mueller, R.; Marmier, P. (Eidgenoessische Technische Hochschule, Zurich). Nucl. Phys.; A184: No. 2, 577-87(1972).

The mechanism of the first step of a sequential decay reaction can be determined by a measurement of the angular correlations, which in turn lead to the polarization of the unstable particle. This method was applied to the reaction $^{12}C(d,pn)^{12}C$; the first step is assumed to be a stripping reaction leading to a doublet of levels in $^{13}N^{*}$. An analysis of the results in PWBA confirms this hypothesis, but the large discrepancies between this model and the measured angular distribution emphasize the importance of initial- and final-state interactions. (auth)

29519 (^{3}He,^{6}Li) REACTION ON ^{9}Be AS A DIRECT REACTION. Young, F. C. (Univ. of Maryland, College Park. Naval Research Lab., Washington, D. C.); Knudson, A. R. Nucl. Phys.; A184: No. 2, 563-73(1972).

The $^{9}Be(^{3}He,^{6}Li)^{6}Li$ reaction (Q = −1.90 MeV) was measured for the energy range from 6.0 to 9.25 MeV. Sharply forward peaked angular distributions at 7.0 and 9.0 MeV and yield curves,

smoothly varying with energy, suggest that the reaction is predominantly direct. Zero-range DWBA calculations, antisymmetrized to account for identical particles in the exit channel, were made for the differential cross section assuming a triton pick-up process. Distorted waves were generated from optical potentials deduced from elastic scattering measurements appropriate to the entrance and exit channels. Spectroscopic factors (core plus triton-cluster parentage) extracted from the distorted-wave analyses, as well as from previous analyses of (^{3}He,^{6}Li) reactions on ^{11}B and ^{19}F, compare favorably with theoretical calculations. The (^{3}He,^{6}Li) reaction promises to be a useful probe of triton clustering in nuclei. (auth)

29520 CHARGED PARTICLE EMISSION FOLLOWING PION CAPTURE IN NUCLEI. Castleberry, Paul John Jr. Charlottesville, Va.; Univ. of Virginia (1971). 88p. University Microfilms Order No. 72-7190.

Thesis.

A beam of negative pions from the 600 MeV synchrocyclotron at the Space Radiation Effects Laboratory of the NASA in Newport News, Virginia, was stopped in thin targets made of ^{6}Li, ^{7}Li, Be, ^{10}B, C, O, Mg, S, Ca, Co, and Pb. The charged particles emitted following the capture of a pion were identified by their total energy and their energy loss in thin planar proportional counters. The energy spectra of the hydrogen isotopes emitted as well as the branching ratios for their production for each target were measured. (Diss. Abstr. Int., B)

29521 QUASIFREE SCATTERING OF 1 GeV PROTONS FROM ^{12}C AND ^{40}Ca. Corley, D. M. (Univ. of Maryland, College Park); Wall, N. S.; Palevsky, H.; (and others). Nucl. Phys.; A184: No. 2, 437-42(1972).

Experimental results for the quasifree scattering of 1-GeV protons from ^{12}C and ^{40}Ca are given. The angular range observed was from about 9 to 20°. The kinematics show that the process is essentially quasifree and the results are briefly discussed relative to several recent calculations that were made. (auth)

29522 POLARIZATION OF PROTONS FROM THE ^{12}C(d,p)^{13}C REACTION. Blue, R. A.; Stout, K. J.; Marr, G. (Ohio State Univ., Columbus). Nucl. Phys.; A184: No. 2, 377-84(1972).

The polarization of protons from the ^{12}C(d,p)^{13}C reaction was measured for deuteron bombarding energies between 3.9 and 5.8 MeV. Angular distributions of the polarization for protons leaving ^{13}C in its ground state were measured for laboratory angles between 10 and 135° at several energies in the vicinity of a resonance at 4 MeV in order to determine the effect of that resonance on the polarization. Additional measurements were made at 0.4 MeV intervals throughout the energy range. These measurements demonstrate that the compound-nuclear resonances observed in the cross section do not significantly alter the polarization angular distributions except at back angles. The shape of the observed polarization angular distributions at all energies is quite similar to previous results obtained for deuteron bombarding energies up to 15 MeV. (auth)

29523 ALPHA-CLUSTER GROUND STATE OF ^{16}O. Abulaffio, C.; Irvine, J. M. (Univ. of Manchester, Eng.). Phys. Lett.; 38B: No. 7, 492-4(3 Apr 1972).

It is shown that there is an α-cluster configuration which is more tightly bound than the optimum regular tetrahedron, which is usually assumed to correspond to the ground state of ^{16}O. There is no sharp minimum in the energy of the ground state of ^{16}O in the α-cluster model; this result suggests that the ground state must be a mixture of α-clusters, or that it is important to treat the cluster co-ordinates as dynamical variables. (auth)

29524 HIGH-SPIN ASSIGNMENTS IN THE 1p-SHELL OBTAINED WITH THE J-DEPENDENT (p,α) REACTION. Maples, C.; Cerny, J. (Univ. of California, Berkeley). Phys. Lett.; 38B: No. 7, 504-6(3 Apr 1972).

Direct (p,α) pickup reactions within the 1p shell induced by 43.7- to 54.1-MeV protons are shown to possess angular distributions with characteristic behavior for J = $\frac{1}{2}$, $\frac{3}{2}$, $\frac{5}{2}$, and $\frac{7}{2}$ transitions. This behavior permits $J^\pi = \frac{1}{2}^-$ assignments in ^{9}B and ^{13}N. (auth)

29525 POLARIZATION IN THE ELASTIC SCATTERING OF PROTONS FROM ^{12}C AT ENERGIES AROUND 4.81 MeV RESONANCE. Nakamura, Masanobu; Takasaki, Eiichi; Takai, Michikatsu; Hasegawa, Takeo; Kobayashi, Shinsaku (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 6, 1942-4(Dec 1971).

The polarization was measured from 4.6 to 5.1 MeV for lab angles of 50 and 137.5°. The results agree with calculations using the rotational model for ^{12}C with a deformation parameter $\beta = -0.5$. (2 figures) (R.W.R.)

29526 ANALYSIS OF α-NUCLEUS SCATTERING BY REGGE-POLE MODEL. Tanimura, Osamu (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 6, 1738-48(Dec 1971).

The validity of describing α-nucleus scattering in terms of trajectories of complex angular momentum poles for the scattering matrix is investigated through analyses of the differential cross sections for ^{12}C(α,α)^{12}C and ^{16}O(α,α)^{16}O. The trajectories and the complex angular momentum representations of the partial wave amplitude are set up for the rotational bands with definite parities. The adequacy of regarding a trajectory as the reflection of a rotational intrinsic state is deduced, and a resonance width is ascribed to the mixings of nonresonant angular momenta. (auth)

29527 ELASTIC SCATTERING OF PROTONS BY OXYGEN ISOTOPES. Lerner, Gerald Michael. College Park, Md.; Univ. of Maryland (1972). 241p. University Microfilms Order No. 72-10,076.

Thesis.

Angular distributions for ^{16}O(p,p)^{16}O, ^{17}O(p,p)^{17}O, and ^{18}O(p,p)^{18}O have been measured at the nominal bombarding energy of 65 MeV. A gas target was used for these experiments. The ^{16}O data has been fit with a standard optical-model search as well as with a generalized optical-model potential derived from three-body theory which uses a fully off-shell T-matrix as the effective interaction. The ^{17}O data was fit using the calculated ^{16}O potential plus the contribution from the valence nucleon. High quality fits to the data have been achieved for both ^{16}O($\chi^2/(N-P) = 3.5$) and ^{17}O($\chi^2/(N-P) = 1.4$). The calculated real well is nonlocal but the velocity-dependent term is only 3-5% of the local term in the significant regions of phase space. Fourier transforming the local part of the potential gives an energy dependent well in configuration space. The energy dependence of the volume integral of the real well is -2.64 fm^3, in good agreement with recent phenomenological results. (auth) (Diss. Abstr. Int., B)

29528 BINDING-ENERGY CALCULATIONS FOR ^{16}O AND THEIR DEPENDENCE ON THE TREATMENT OF THE PAULI OPERATOR IN THE G-MATRIX. Barrett, B. R. (Univ. of Arizona, Tucson); Hewitt, R. G. L.; McCarthy, R. J. Nucl. Phys.; A184: No. 1, 13-22(1972).

The binding energy per particle and the single-particle energies and occupation probabilities for ^{16}O are calculated using G-matrix elements computed with an exact Pauli operator, Q, and with various shifts in the energies of the intermediate-state spectrum with respect to the energies of the occupied states. These calculations are then repeated with G-matrix elements computed with several commonly used approximations for Q, namely the Eden-Emery Q and the angle-averaged Q of Wong. The results of these latter calculations are compared with the results obtained with the exact treatment of Q and are found to be very similar. It is concluded that in binding-energy calculations, but not necessarily in more sophisticated calculations, the approximate treatments of Q discussed in this paper can be used to obtain reasonable results. (1 figure, 4 tables) (auth)

29529 (p,^{4}He) REACTION MECHANISMS IN LIGHT NUCLEI. DeVries, Ralph Milton. Los Angeles; Univ. of California (1971). 149p. University Microfilms Order No. 72-2801.

Thesis.

The (p,^{4}He) angular distributions were measured for the first three states in the reaction ^{9}Be(p,^{4}He)^{6}Li and for the first two states in the reaction ^{11}B(p,^{4}He)^{8}Be. Data were obtained between center of mass angles of 20 and 160°. All cross sections were found to rise at backward angles. Also the ^{9}Be(p,^{6}He)^{3}He p cross section was obtained at several angles. Zero range DWBA calculations were performed for pick-up and knock-on of both light and heavy clusters. It appears that the knock-on mechanisms are considerably less important than the pick-up mechanisms. Calculations were also made using first order corrections to the zero range approximation and using the "fixed-range" approximation. An exact finite range DWBA computer program was written and comparison made between these exact results and the previous approximations. The exact calculations reproduce the data reasonably well, and the spectroscopic factors derived seem reasonable. (Diss. Abstr. Int., B)

29530 LOW-ENERGY NEUTRINO EXCITATION OF THE GIANT RESONANCE IN ^{12}C. Kelly, Francis J. (Naval Research Lab., Washington, D. C.); Ueberall, H. Phys. Rev., C; 5: No. 4, 1432-4(Apr 1972).

Theoretical cross sections are presented for the excitation of the giant resonances in ^{12}C by electron neutrinos with energies E_ν = 15 to 75 MeV. Although the excitation strengths of the individual giant-resonance levels are somewhat different for the two particle-hole models used (Lewis-Walecka-deForest's and Gillet's models), the total summed are similar. (2 figures, 1 table) (auth)

29531 NUCLEAR QUADRUPOLE COUPLING OF ^{12}B IN A SINGLE Be CRYSTAL. Williams, R. L. Jr.; Haskell, R. C.; Madansky, L. (Johns Hopkins Univ., Baltimore). Phys. Rev., C; 5: No. 4, 1435-7(Apr 1972).

Quadrupole resonance lines of β-unstable ^{12}B were distinctly resolved in a single crystal of Be, and behaved properly under field reversal and variation of the angle θ between crystal c axis and external magnetic field. (2 figures, 1 table) (auth)

29532 HIGH-RESOLUTION NEUTRON RESONANCE SPECTROSCOPY IN NATURAL FLUORINE, ALUMINUM, CHLORINE, AND POTASSIUM. Singh, U. N. (State Univ. of New York, Albany); Garg, J. B.; Rainwater, J.; (and others). pp 81-90 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

High-resolution neutron total cross sections up to about 200 keV for natural fluorine, aluminum, chlorine, and potassium. An R-matrix analysis of the data was performed. Resonance parameters and strength functions were extracted. (J.W.R.)

29533 COMPOUND NUCLEUS REACTIONS BETWEEN OXYGEN IONS AND ^{16}O, ^{12}C, AND ^{14}C TARGETS. Eyal, Y.; Dostrovsky, I.; Fraenkel, Z. (Weizmann Inst. of Science, Rehovoth, Israel). pp 527-34 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The basic assumption underlying the analysis of compound nucleus reactions is the Bohr independence hypothesis which supposes the decay of the compound nucleus to be independent of its mode of formation. The validity of the independence hypothesis for heavy ion reactions was tested by comparing the cross sections for the residual nuclei ^{28}Al and ^{29}Al from the reactions $^{18}O + ^{12}C$ and $^{16}O + ^{14}C$ over the excitation energy range of the compound nucleus ^{30}Si of 30-40 MeV. Also, the importance of the angular momentum in compound nucleus reactions of heavy ions was investigated by comparing the experimental formation cross sections of several residual nuclei from the above reactions and from the $^{18}O + ^{16}O$ and $^{18}O + ^{14}C$ reactions with statistical model calculations which neglect momentum effects and with calculations which take into account in a detailed fashion the effects of the angular momentum on the decay of the compound nucleus. (auth)

29534 ELASTIC SCATTERING OF ^{7}Li FROM LIGHT TARGET NUCLEI. Weber, K. A.; Meier-Ewert, K.; Schmidt-Boecking, H.; Bethge, K. (Univ., Heidelberg). Nucl. Phys.; A186: No. 1, 145-51(1972).

The elastic scattering of ^{7}Li from ^{9}Be, ^{10}B, and ^{12}C has been measured and analyzed in terms of an optical model. The best-fit parameter sets reflect the strong absorption of lithium nuclei. The backward rise of the differential cross section for the scattering on ^{12}C has been attributed to a five-particle transfer process. (auth)

29535 INTERFERENCE EFFECTS IN THE $^{11}B(p,3\alpha)$ REACTION AT E_p = 163 keV. Hudomali, J. (Inst. Ruder Boskovic, Zagreb); Antolkovic, B.; Schaefer, K.; Valkovic, V. Nucl. Phys.; A186: No. 1, 200-8(1972).

The nuclear reaction $^{11}B(p,3\alpha)$ has been studied at E_p = 163 keV under kinematical conditions necessary for the observation of interference effects. Experimental information about these effects has been found for a few pairs of angles in a coplanar geometry. The change of the two-particle resonance width of the ^{8}Be first excited state has been successfully explained. (auth)

29536 PRODUCTION OF ^{8}B IN THE CAPTURE OF STOPPED π^- MESONS BY N NUCLEI. Agababyan, N. M.; Batusov, Yu. A.; Bunyatov, S. A.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 15: No. 1, 18-21(Jan 1972). (In Russian).

Using the kinematic analysis the events with the ^{8}B fragment production in the capture of stopped π^- mesons by light nuclei in photoemulsion were selected from 1500 events of two-prong type with T-shape track. It is shown that ^{8}B is mainly produced in absorption of π^- mesons by N nuclei. Relative probability of ^{8}Be production in reactions on N is found to be (1 to 1.3) $(10)^{-3}$. Upper limits for the probability of the multineutron bound states (n^3, n^4, and n^5) as well as of the neutron-excess isotope ^{6}H in reactions involving ^{8}B production on N are given. (auth)

29537 ^{16}O AND ^{19}F INDUCED MULTI-NUCLEON TRANSFER REACTIONS IN LIGHT NUCLEI. Schlotthauer-Voos, Ursula C.; Bock, R.; Bohlen, H. G.; Gutbrod, H. H.; Von Oertzen, W. (Max-Planck-Institut fuer Kernphysik, Heidelberg. Univ., Marburg, Ger.). Nucl. Phys.; A186: No. 2, 225-44(1972).

Triton, α-particle, five- and nine-nucleon transfer reactions induced by ^{19}F in ^{12}C and ^{16}O in ^{11}B at incident energies above the Coulomb barrier have been measured in order to study the nuclear structure of ^{15}N, ^{16}O and ^{20}Ne, and the reaction mechanism. The possibility of obtaining spectroscopic information by a comparison of the spectra and cross sections in the different reactions is discussed. DWBA calculations with the fixed-range model show that the strongly absorbing optical potentials extracted from the analysis of the elastic scattering and successfully used for different heavy-ion-induced proton transfer reactions can be applied to heavy-ion-induced multi-nucleon transfer reactions. (auth)

29538 ENERGY LEVELS OF ^{13}B UP TO 8.7 MeV. Wyborny, H. W. (Univ. of Iowa, Iowa City). Nucl. Phys.; A185: No. 2, 669-72(1972).

Energy levels of ^{13}B were measured by means of the reaction $^{7}Li(^{7}Li,p)^{13}B$ at an energy of 14 MeV for the incident ^{7}Li ions. Excitation energies of seven new states, based upon an assumed excitation energy for the fifth excited state of 4.132 MeV, are 5.558, 6.420, 6.940, 7.517, 7.860, 8.130 and 8.683 MeV. Uncertainties range from 8 to 20 keV. (auth)

29539 IN-PLANE AND OUT-OF-PLANE $\alpha-\gamma$ CORRELATION EXPERIMENTS ON ^{12}C. Burdzik, G. F.; Heymann, G. (National Physical Research Lab., Pretoria). Nucl. Phys.; A185: No. 2, 509-28(1972).

The relative correlation function describing the angular correlations between α-particles inelastically scattered from the 2^+(Q = −4.439 MeV) excited state of ^{12}C and the γ-rays emitted when the excited nucleus decays was measured both in and outside the reaction plane, at a beam energy of 32.5 MeV. From the data it was possible to deduce values for all four polarization parameters which describe the polarization of the excited nucleus. However, as the circular polarization of the γ-rays was not measured, the polarization parameters are ambiguous. In addition, the elastic and 2^+ inelastic differential cross sections were measured, and the partial cross sections of the angular momentum substates of the 2^+ state deduced. A fairly thorough attempt was made to fit optical model and distorted-wave Born approximation cross sections to the experimental results. (auth)

29540 GIANT DIPOLE RESONANCES IN ^{12}C OBSERVED WITH THE POLARIZED PROTON CAPTURE REACTION. Glavish, H. F.; Hanna, S. S.; Avida, R.; (and others) (Stanford Univ., Calif.). Phys. Rev. Lett.; 28: No. 12, 766-9(20 Mar 1972).

The giant E1 resonances of ^{12}C have been studied with the polarized-proton capture reactions $^{11}B(p,\gamma_0)^{12}C$ and $^{11}B(p,\gamma_1)^{12}C$. The effects of proton polarization on the angular distributions were large and of opposite sign for γ_0 and γ_1. Coupled with the unpolarized measurements the polarized results produce additional significant limitations on the allowed configurations of the giant E1 resonances in ^{12}C. (auth)

29541 HYPERFINE INTERACTIONS OF THE FIRST EXCITED 2^+ STATE OF ^{18}O IN 7^+ AND 6^+ IONS. Goldring, G. (Oxford Univ.); Hutcheon, D. A.; Randolph, W. L.; (and others). Phys. Rev. Lett.; 28: No. 12, 763-6(20 Mar 1972).

Perturbed angular correlations were measured between 1.98-MeV γ rays de-exciting the 3.3-psec 2^+ state of ^{18}O and the $^{18}O^*$ particles following the reaction $^{12}C(^{18}O,^{18}O^*)^{12}C$ at 33 MeV. A magnetic spectrometer was used to resolve the $^{18}O^*$ ions into the component 8^+, 7^+, and 6^+ charge states, and the correlations were determined separately for each. The measurements yield information on hyperfine interactions in the 7^+ and 6^+ charge states. Limits are obtained on the ionic ground-state occupancies and on the value of the nuclear g factor. (auth)

29542 $^{14}N(\alpha,n)$ AND $^{16}O(d,n)$ EXCITATION FUNCTIONS. Gruhle, W.; Schmidt, W.; Burgmer, W. (Univ., Cologne). Nucl. Phys.; A186: No. 2, 257-63(1972).

The excitation functions for $^{14}N(\alpha,n)^{17}F$ and $^{16}O(d,n)^{17}F$ have been studied from threshold to about 20 MeV excitation energy. The cross sections are compared with Hauser-Feshbach calculations. They show less than a 10% compound nuclear fraction in the case of the (α,n) reaction and a very small compound contribution in the (d,n) reaction. However, mean level widths and variances taken from a fluctuation analysis agree well with the predictions of the statistical model. An intermediate gross structure is observed in both functions. (auth)

29543 SPIN-FLIP PROBABILITY IN THE INELASTIC SCATTERING OF 7.5-MeV NEUTRONS FROM CARBON. McDaniel, Floyd Delbert. Athens, Ga.; Univ. of Georgia (1971). 149p. University Microfilms Order No. 72-11,006.

Thesis.

The angular distribution of the spin-flip probability for 7.5 MeV neutrons scattered from the first $J^\pi = 2^+$ state in carbon

was determined. The experimental technique was patterned after that originally used by Schmidt, et al. (Nucl. Phys. 52 (1964) 353) for proton spin-flip measurements. The neutron spin-flip results were found to be very similar to the results obtained for the proton spin-flip probability in the 10–12 MeV region. In addition, relative elastic and inelastic scattering angular distributions were measured. Multiple-scattering corrections were applied to both the elastic and inelastic scattering angular distributions. The correction consisted of a combination of Monte Carlo and analytical methods. A microscopic antisymmetrized distorted wave calculation, including direct and exchange amplitudes, was used to obtain a theoretical interpretation of the results. The transition operator consisted of a two-nucleon interaction component and a core polarization interaction component. The Hamada–Johnston potential was used to represent the two-nucleon interaction while a collective model representation was used for the core polarization term. The theoretical results were found to be dominated by the core polarization contributions. (Diss. Abstr. Int., B)

29544 STUDY OF THE $^{13}C(^{3}He,n)^{15}O$ REACTION AT 5.5 AND 6.2 MeV. Etten, Marvin Paul Jr. Charlottesville, Va.; Univ. of Virginia (1971). 135p. University Microfilms Order No. 72-7258.

Thesis.

Using time-of-flight techniques the absolute differential cross sections of 18 levels populated in the $^{13}C(^{3}He,n)^{15}O$ reaction were measured at scattering angles from 0 to 160 degrees at a flight path of seven meters. Angular distributions of the neutron yield were measured at ^{3}He bombarding energies of 5.5 and 6.2 MeV. A new spin and parity assignment of $1/2^-$ is made for the 10.466 MeV excitation state in ^{15}O. Spectroscopic factors and statistical compound nucleus contributions are obtained by treating the observed cross sections as an incoherent sum of distorted wave Born approximation and compound nucleus contributions. Analysis was performed with the DWBA code DWUCK and the Hauser–Feshbach–Moldauer code MANDY. (Diss. Abstr. Int., B)

29545 OPEN QUESTION OF THE 0^+ STATES IN ^{18}Ne. Rose, H. J.; Gill, R. D.; Caraca, J. M. G.; Cox, A. J. (Oxford Univ.). Particles Nucl.; 1: No. 8, 453-8(May 1971).

To remove the discrepancies which recently have arisen regarding the $^{18}O-^{18}Ne$ symmetry (in particular, the location of the first excited 0^+ state and the cross-over branch from the second excited 2^+ state to the ground state of ^{18}Ne), an experiment is reported which uses neutron-time-of-flight γ-ray associated spectrometry. The results unambiguously confirm the location of the 0^+ state at 3576 keV and the existence of the cross-over branch with a strength comparable to the analog branch in ^{18}O. (2 figures) (auth)

29546 FORM FACTORS AND ANALYSIS OF (p,d) PICK-UP FOR SOME LIGHT NUCLEI. McAllen, G. M. (Vanderbilt Univ., Nashville); Pinkston, W. T.; Satchler, G. R. Particles Nucl.; 1: No. 7, 412-45(Apr 1971).

The microscopic approach to calculating form factors for single-nucleon-transfer reactions is applied to several pickup reactions on ^{12}C, ^{14}N, and ^{16}O. It is shown that for such nuclei one obtains the greatest discrepancies between such form factors and form factors obtained from the conventional well-depth procedure. Unfortunately, it is also for such light nuclei that the usual distorted-wave method is most difficult to apply. Because of the ambiguity resulting from the necessity of using sharp radial cutoffs in the distorted-wave integrals and the sensitivity of results to the cutoff used, the adiabatic model of Johnson and Soper for the deuteron distorted waves was also used. Considerable improvement is found for the strong transitions. A cutoff is no longer required. However, the results for the weak transitions, for which microscopic form factors were used, were little changed, so that the interpretation of these remains inconclusive. The changes in cross section produced by using the microscopic form factor are comparable for the two distorted-wave prescriptions. (11 figures, 5 tables) (auth)

29547 HIGH ENERGY PROTON ELASTIC SCATTERING FROM FOUR-PARTICLE CLUSTERS IN ^{12}C. Raphael, Robert B. (Emory Univ., Atlanta. Naval Research Lab., Washington, D. C.); Rosen, Mervine. Particles Nucl.; 2: No. 1, 29-46(Jul 1971).

The elastic scattering of 1-GeV protons from ^{12}C is calculated using Glauber multiple scattering theory. Deformation in the carbon density is introduced using the Perring–Skyrme α-cluster model. Good agreement is found with the experimental data. (auth)

29548 LARGE γ-RAY AND α-PARTICLE REDUCED WIDTHS OF THE 2260 keV $^{18}O + p$ RESONANCE. Wormald, M. R.; Wright, I. F. (Univ. of Manchester, Eng.). Particles Nucl.; 2: No. 3, 168-72(Sep 1971).

An investigation of the γ rays from the 2260-keV resonance in $^{18}O + p$ (E_x = 10129 keV) shows that this state has $J^\pi = 3/2^-$. The E1 transitions to the ground state and 197-keV state are unusually strong, 0.15 W.u. and 0.08 W.u., respectively. The widths for α-particle decay to the 5270- and 5300-keV levels in ^{15}N are also large and of the order of the Wigner limit. (2 figures, 1 table) (auth)

Nuclear Properties and Reactions, 20 ≤ A ≤ 38

Refer also to abstracts 29510, 29514, 29516, 29520, 29521, 29532, 29591, 29613, 29640, 29768, and 29829.

29549 (AD–734205) GAMMA-RAY PRODUCTION CROSS SECTIONS FOR IRON AND ALUMINUM. Final Report. Orphan, Victor J.; Hoot, Charles G. (Gulf Radiation Technology, San Diego, Calif.). Jul 1971. Contract DASA01-69-C-0083. 182p. (GULF-RT-A-10743; DNA-2736-F). NTIS.

The Linac time-of-flight technique has been used to measure the differential gamma-ray production cross sections for neutron interactions with natural Fe and Al in the neutron energy range 0.9 to 17 MeV. Ring-shaped scattering samples were placed at the terminus of a 51-meter neutron flight path at the Gulf Radiation Technology Linac facility. The gamma rays from (n,x gamma) reactions were detected with an 80-cc Ge(Li) detector placed on the centerline of the flight path so as to observe gamma rays emitted from the samples at an angle of about 125 degrees with respect to the incident neutron beam. This angle minimized the effect of gamma-ray anisotropy on the determination of the angle-integrated cross section. (auth) (NTIS)

29550 (AD–734245) EXPERIMENTAL AND THEORETICAL INVESTIGATION OF THE ODD-PARITY SPECTRUM OF THE ^{34}Cl NUCLEUS. Hyder, Anthony Kalil Jr. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). Jun 1971. 127p. (DS/PH–71-1). NTIS.

Thesis.

An experimental and theoretical study of the odd-parity states in ^{34}Cl has been made to identify major components of the 1d ($3/2$)-1f ($7/2$) and 1d ($3/2$)-2p ($3/2$) spectra. Resonances in the $^{33}S(p,\gamma)^{34}Cl$ reaction at proton energies of 1058, 1098, and 1121 keV were investigated using an 80 cc Ge(Li) detector. A revised Q-value, Q = 5139.9 plus or minus 0.9 keV, and the excitation energies of fourteen bound levels, 2.3 MeV < or = E sub x < or = 4.7 MeV, were obtained, and decay schemes of the three resonance levels and eleven odd-parity bound states were deduced from the gamma-ray spectra. The spins of several odd-parity levels were also determined. A six-particle shell-model calculation yielding energies and wavefunctions of odd-parity levels in mass-33 and mass-34 nuclei was also performed. (auth) (NTIS)

29551 (ANU-P–532) TENSOR POLARIZATION AND DIFFERENTIAL CROSS SECTIONS FOR THE ELASTIC SCATTERING OF DEUTERONS BY Si AT LOW ENERGIES. Djaloeis, A.; Nurzynski, J. (Australian National Univ., Canberra. Dept. of Nuclear Physics). [1971]. 16p. Dep. NTIS (U. S. Sales Only).

Angular dependence of the three components T_{20}, T_{21} and T_{22} of the tensor polarization of deuterons from the Si(d,d)Si elastic scattering has been measured. The energy of projectiles was 7 MeV, and the scattering angles were between 15° and 90° (lab) in steps of 7.5°. The experimental data were analyzed using optical model without and with the inclusion of the Hauser–Feshbach correction. The addition of small, attractive and long-ranged tensor interaction T_R to the central and spin-orbit forces was found necessary to account for the observed features of the tensor polarization. (auth) (Australia)

29552 (FRNC-TH–148) STUDY OF THE KNOCK-ON OF LIGHT NUCLIDES IN INTERACTIONS BETWEEN HIGH ENERGY PROTONS AND NUCLEI: COMPARISON WITH THEORETICAL MODELS; APPLICATIONS TO ASTROPHYSICS. Alard, Jean-Pierre (Clermont-Ferrand Univ. (France)). 1971. 131p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

After having reviewed the problems related to cosmic radiation, the propagation of cosmic rays in interstellar gas and the formation of singly or doubly charged light isotopes by fragmentation are discussed. Various theories enabling the ejection of light fast fragments (p,d,t, ^{3}He and ^{4}He) to be explained are suggested: nuclear evaporation, pick-up reactions, direct knock-on reactions, and statistical theories. In particular, a thermodynamic interaction theory (p + nucleus) developed from the theory of Hagedorn is presented, this theory allowing the shape of the energy spectra and various production ratios between light nuclides to be pre-

dicted. Experiments were conducted in order to verify this theory: incident protons beams with energies of 20 GeV and 600 MeV were made to bombard Al, C, Fe, Ag and Au targets. The following production ratios were determined: d/p, t/d, $t/^3He$ and $^3He/^4He$. (France)

29553 (N-71-37201) INELASTIC SCATTERING CALCULATIONS WITH PROJECTED HARTREE–FOCK WAVE FUNCTIONS: COUPLED CHANNEL TREATMENT. Ascuitto, Robert J.; Braley, Richard C.; Ford, William F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sep 1971. 22p. (NASA-TN-D-6419; E-6068). NTIS.

A completely microscopic coupled-channel study of proton inelastic scattering is made. Proton scattering from ^{20}Ne and from ^{24}Mg is investigated. At least the 0(+), 2(+), and 4(+) members of the ground state rotational band of each nucleus are included explicitly in the coupled equations. The nuclear wave functions are obtained by projecting states of good angular momentum from deformed Hartree–Fock intrinsic states. The scattering results are compared with the distorted wave Born approximation (DWBA) and experiment. Truncation of the nuclear model space is also investigated. The results obtained with the microscopic model confirm conclusions drawn earlier based on the macroscopic model. The shapes and deformations predicted by the macroscopic model are well reproduced by the projected Hartree–Fock model which is based purely on energy considerations. (auth)

29554 NUCLEAR LIFETIMES MEASURED BY THE RECOIL DISTANCE METHOD. Snyder, Franklin Douglas. Iowa City, Iowa; Univ. of Iowa (1971). 78p. University Microfilms Order No. 72-8325.

Thesis.

The Recoil Distance Method was used to measure electromagnetic transition probabilities in ^{19}F, ^{22}Na, ^{22}Ne, and ^{30}P. A new type of Recoil Distance instrument improved previous determinations for some of the lifetimes and confirmed the remainder. The mean lives in ps were: $^{19}F_{1.346\to0.110}(4.8 \pm 1.3)$, $^{22}Ne_{1.275\to0}(5.9 \pm 1.1)$, $^{22}Na_{0.891\to0}(16.1 \pm 3.0)$, $^{22}Na_{1.528\to0}(4.5 \pm 0.8)$, $^{30}P_{0.709\to0}(53 \pm 10)$, $^{30}P_{1.453\to0}(6.5 \pm 3.0)$. (Diss. Abstr. Int., B)

29555 PHOTONUCLEAR REACTIONS OF ^{27}Al. Oda, Yukiyasu; Kondo, Motoo; Hirabayashi, Hiromi (Tokyo Inst. of Tech.). J. Phys. Soc. Jap.; 32: No. 4, 869-85(Apr 1972).

The experimental studies of $^{27}Al(\gamma,p)$ reaction are described. Firstly, this reaction was studied at maximum bremsstrahlung energies $E_\gamma(max) = 22$, 20 and 15 MeV. The energy spectrum of the product protons showed existence of many groups which were supposed to arise from 26 states of ^{27}Al of energies $9.99 \le E_x \le 20.4$ MeV. Secondly, the existence of these states was examined in the $^{26}Mg(p,p')$, $(p,p'\gamma)$, (p,n), (p,γ), $^{25}Mg(d,p)$ and $^{27}Al(p,p')$ reactions. The results are consistent with that of the initial photonuclear reactions. Differences of features were found below and in the giant resonance region of ^{27}Al. The integrated cross sections and the γ-ray widths for the ground state transitions in this reaction were estimated numerically. (auth)

29556 ANGULAR-DISTRIBUTION MEASUREMENTS OF GAMMA RAYS FROM THE $^{22}Ne(p,\gamma)^{23}Na$ REACTION. Viitasalo, M.; Piiparinen, M.; Anttila, A. (Univ. of Helsinki). Z. Phys.; 250: No. 5, 387-94(1972).

Angular-distribution measurements of gamma rays from the $^{22}Ne(p,\gamma)^{23}Na$ reaction on the E_p = 897-, 1106-, 1091-, and 1278-keV resonances were made. Spin and parity assignments for several bound states are presented, together with multipole mixing ratios for transitions from resonance and bound states. The level at 6617 keV ($^7/_2^+$) is proposed to be a member of the rotational band based on the Nilsson orbit $5(K^\pi = 5/_2^+)$. (auth)

29557 MEASUREMENT OF THE LIFETIME OF THE 1.01 MeV LEVEL OF ^{27}Al. Imada, H.; McIntyre, J. A. (Texas A and M Univ., College Station). Nucl. Phys.; A184: No. 2, 574-6(1972).

The mean lifetime for the 1.01-MeV level in ^{27}Al was measured to be 2.13 ± 0.19 ps. This value agrees with two previous measurements but disagrees by a factor of four from the most recently published lifetime. (auth)

29558 CALCULATION OF T = 2 → T = 1 → T = 0 M1 DECAYS IN A = 20 AND A = 32 NUCLEI. Maripuu, S. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio); Eildenthal, B. H. Phys. Lett.; 38B: No. 7, 464-6(3 Apr 1972).

Absolute strengths and branching ratios are calculated for M1 transitions between states of different isospin in two A = 4n nuclei of the sd shell. (auth)

29559 COMPOUND NUCLEUS EFFECTS IN $^{24}Mg + \alpha$ ELASTIC SCATTERING AT 20 TO 23 MeV. Drentje, A. J.; Roeders, J. D. A. (Univ., Groningen, Netherlands). pp 351-8 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

Excitation functions and angular distributions for $^{24}Mg + \alpha$ elastic scattering show at extreme backward angles important contributions of compound nucleus reactions. Several reaction mechanisms are discussed to explain the angular distributions. (auth)

29560 FLUCTUATION ANALYSIS OF TOTAL NEUTRON CROSS SECTIONS. Kopsch, D.; Cierjacks, S. (Kernforschungszentrum, Karlsruhe, Ger.). pp 455-61 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

A fluctuation analysis of neutron total cross sections for F, Na, Al, Si, S, K, Ca, V, Cr, Mn, Fe, Co, and Ni in the energy range 0.8 to 14 MeV was performed. Average level densities and level widths were extracted. A search for intermediate structure was included in the analysis. (J.W.R.)

29561 REACTION $^{27}Al(d,p)^{28}Al$ AT E_d = 23 MeV. Maher, J. V.; Fortune, H. T.; Morrison, G. C.; Zeidman, B. (Argonne National Lab., Ill.). Phys. Rev., C; 5: No. 4, 1313-22(Apr 1972).

The reaction $^{27}Al(d,p)^{28}Al$ was investigated at a deuteron energy of 23 MeV. Distorted-wave analyses of the angular distributions for the low-lying states of ^{28}Al were carried out for several sets of optical-model parameters. The spectroscopic factors obtained for states up to 2.66 MeV excitation in ^{28}Al are in qualitative agreement with shell-model predictions. It is found, however, that the results of analysis are sensitive to the choice of parameters, and there is difficulty in extracting reliable quantitative spectroscopic information from this reaction without the use of information from other reactions. (9 figures, 5 tables) (auth)

29562 CHARGE-ASYMMETRY MEASUREMENTS IN REACTIONS $^{32}S(d,^3He)^{31}P$ AND $^{32}S(d,t)^{31}S$. Dzubay, T. G.; Poore, R. V. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.). Phys. Rev., C; 5: No. 4, 1304-13(Apr 1972).

Simultaneous measurements of $^{32}S(d,^3He)^{31}P$ and $^{32}S(d,t)^{31}S$ cross sections were made at beam energies of 17.7, 20.8, and 23 MeV. The experimental angular distributions and charge asymmetries are adequately described in terms of distorted-wave Born-approximation calculations. Spectroscopic factors are found to be the same for $(d,^3He)$ and (d,t) reactions within an accuracy of 5%. Ratios of cross sections for transitions to the ground states are found to decrease from 4.6 at 17.7 MeV to 2.5 at 23 MeV. Included in the ratios is a calculated factor of 1.8, which is due to a difference between single-particle wave functions of the transferred proton and neutron. A numerical estimate of the isospin impurity of the ground state of ^{32}S is made from these differences. (auth)

29563 ENERGY LEVELS OF ^{28}Si FROM THE REACTION $^{28}Si(^3He,^6He)^{25}Si$ AT 70.4 MeV. Benenson, W. (Michigan State Univ., East Lansing); Driesbach, J.; Proctor, I. D.; Trentelman, G. F.; Preedom, B. M. Phys. Rev., C; 5: No. 4, 1426-8(Apr 1972).

The energy levels of ^{25}Si were measured by detecting ^6He particles from the reaction $^{28}Si(^3He,^6He)^{25}Si$ in photographic plates on the focal plane of a spectrometer. Twelve excited states were observed. The observation of a weak state at 40 keV excitation leads to a new ^{25}Si ground-state mass excess, 3.824 ± 0.010 MeV. The observed levels are discussed in terms of the isobaric multiplet mass equation and the shell model. (2 figures, 2 tables) (auth)

29564 NEW ISOTOPE OF SILICON: 6.3-sec ^{33}Si. Goosman, D. R.; Alburger, D. E. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 5: No. 4, 1252-7(Apr 1972).

^{33}Si was produced via the $^{18}O + ^{18}O \to {}^{33}Si + 2p + n$ reaction using 23- to 40-MeV ^{18}O ions. Identification was made from the observed γ rays of 1431.3 ± 0.5, 1847.69 ± 0.25, and 2538 ± 2 keV, which agree with the first three excited states of ^{33}P. By means of the reaction $^{31}P(t,p)^{33}P$, γ rays from the first two excited states of ^{33}P were measured as 1431.4 ± 0.3 and 1847.60 ± 0.15 keV. The three ^{33}Si γ rays decay together, and a value of $T_{1/2}$ = 6.3 ± 0.3 s is obtained from the 1848-keV line. Relative γ intensities correspond to ^{33}Si β branches to the 1431-, 1848-, and 2539-keV states of ^{33}P in the ratios 0.06 ± 0.06 : 1 : 0.10 ± 0.02. No information was obtained on a possible ^{33}Si ground-state β branch. The results are consistent with the expected mass and spin-parity ($J^\pi = 3/_2^+$) of the ^{33}Si ground state. (5 figures, 3 tables) (auth)

29565 INVESTIGATION OF THE REACTION $^{26}Mg(p,t)^{24}Mg$ NEAR E_p = 26 MeV. Shepard, J. R.; Kraushaar, J. J.; Baer, H. W. (Univ. of Colorado, Boulder). Phys. Rev., C; 5: No. 4, 1288-94(Apr 1972).

Experimental cross sections for the first eight triton groups in the reaction $^{26}Mg(p,t)^{24}Mg$ were measured over an angular range 10 to 168° (lab) at two incident proton energies, 25.4 and 26.8 MeV. Distorted-wave Born-approximation (DWBA) calculations were able to describe general trends in the angular distributions for low-lying states; however, higher-lying states showed dramatic rearward enhancement relative to the DWBA cross sections. Excitation functions of all eight triton groups were measured at four angles over a beam energy range 24.96 to 27.20 MeV. The excitation functions are nearly flat for all states; further, the angular distributions show no large changes with energy. These data indicate that compound-nucleus effects are not dominant. Thus, the results suggest that the population of the unnatural-parity 3^+ state at 5.22 MeV excitation is primarily through a direct-reaction mechanism, possibly a multistep process of the type shown to be important in (p,t) reactions by Ascuitto and Glendenning. The roles of spin transfer and multistep effects in the transition to the 5.22-MeV 3^+ state in ^{24}Mg were investigated, the latter being the more probable mode of excitation. (3 figures, 2 tables) (auth)

29566 STUDIES ON ANALOG STATES IN ^{33}Cl BY ISOSPIN-FORBIDDEN RESONANCES IN THE REACTION $^{32}S(p,\gamma)^{33}Cl$. Eswaran, M. A.; Ismail, M.; Ragoowansi, N. L. (Bhabha Atomic Research Centre, Trombay, India). Phys. Rev., C; 5: No. 4, 1270-7(Apr 1972).

The residual activity between bursts of a mechanically chopped beam was used to measure the yield of the reaction $^{32}S(p,\gamma)^{33}Cl$ systematically in the bombarding energy range E_p = 3.36 to 5.41 MeV. Two T = ½ states in ^{33}Cl at E_p = 3.371 ± 0.005 MeV, E_x = 5.550 ± .007 MeV and at E_p = 5.282 ± .006 MeV, E_x = 7.402 ± .008 MeV were located with the resonance strengths $(2J+1)\Gamma_{p_0}\Gamma_\gamma/\Gamma$ = 0.76 ± 0.18 and 1.50 ± 0.37 eV, respectively. Each of these resonances was narrower than the estimated 2-keV spread in the proton beam. These two states are interpreted as the analogs of the ground and the second excited state of ^{33}P with J^π values $\frac{1}{2}^+$ and $\frac{1}{2}^+$, respectively. γ decay of the lower resonance, investigated with a Ge(Li) detector, shows >88% and <12% branchings to the first excited state and ground state of ^{33}Cl, respectively. The M1 strengths of these transitions are compared with those obtained from β analog transitions and with the theoretical predictions based on many-particle shell-model calculations. (5 figures, 4 tables) (auth)

29567 SEARCH FOR NONDIRECT EFFECTS IN THE $^{28}Si(p,p_{0,1,2})^{28}Si$ EXCITATION FUNCTION FROM 16 TO 18.2 MeV. Kemper, K. W.; Fox, J. D.; Oliver, D. W. (Florida State Univ., Tallahassee). Phys. Rev., C; 5: No. 4, 1257-60 (Apr 1972).

Excitation functions were measured at laboratory angles of 60, 80, and 120° in 50- to 100-keV steps for proton scattering from the 0^+, 2^+, and 4^+ members of the ground-state rotational band in ^{28}Si. Prominent structure of width 300 keV is seen in both the 2^+ and 4^+ cross sections at all three angles and throughout the entire energy range from 16 to 18.2 MeV. At 60°, there is a 30% change in the 2^+ and 4^+ cross sections over the resonance at 17.7 MeV. The presence of this structure makes very dubious the quadrupole and hexadecapole deformations extracted from direct-reaction analyses of proton scattering below 18 MeV. (3 figures) (auth)

29568 γ-RAY TRANSITIONS IN ^{36}S. Samworth, E. A.; Olness, J. W. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 5: No. 4, 1238-47(Apr 1972).

A Ge(Li) detector was used to measure γ-ray transitions in ^{36}S via p–γ coincidence studies in the $^{34}S(t,p\gamma)^{36}S$ reaction at E_t = 3.1 MeV. Measurements were carried out at γ-ray detection angles of 0, 45, and 90°. Analyses of the Doppler-shift attenuations evident in the primary γ-ray transitions were used to determine mean lives of ^{36}S states. Angular-correlation analysis confirms previous spin–parity assignments of 2^+, 3^-, 1^+, and 2^+ for the states at 3.29, 4.19, 4.52, and 4.57 MeV, respectively. The "level" previously reported at 6.20 MeV was found to be a doublet of ~38-keV separation; in other respects the present work largely confirms previous conclusions on the γ-ray branching of states of ^{36}S. The excitation energies, given in keV, together with the mean lifetimes (in ps) deduced from these measurements are as follows: 3291 (0.11 ± 0.03); 4192 ($1.1^{+0.3}_{-0.2}$); 4523 (0.025 ± 0.012); 4575 (0.080 ± 0.015); 5251 (0.10 ± 0.04); 5391 (···); 5509 (0.27 ± 0.06); 5573 (<0.2); 6187 (0.08 ± 0.03); and 6225 (<0.03). The energy uncertainties are ≤1 keV. No evidence was seen for γ decays to the 0^+ level at 3346 ± 4 keV. (4 figures, 4 tables) (auth)

29569 RADIATIVE DECAY OF THE ^{29}P 8.38-MeV LEVEL. Bardin, T. T.; Becker, J. A.; Fisher, T. R. (Lockheed Palo Alto Research Lab., Calif.). Phys. Rev., C; 5: No. 4, 1351-6(Apr 1972).

The reaction $^{28}Si(p,\gamma)^{29}P$ at the E_p = 5.834 MeV resonance was used to populate the ^{29}P 8.38-MeV level, thought to be the first ^{29}P level with T = ½. A 32-cm³ Ge(Li) counter was used to study the γ radiations from this state; γ-ray energies (keV), together with the ^{29}P transition assignment (MeV), and branching ratios (%) are 7000.0 ± 1.8 (8.38 → 1.38), 15.3 ± 1.5; 6430.3 ± 2.6 (8.38 → 1.95), 54.1 ± 2.4; and 5962.3 ± 2.6 (8.38 → 2.42), 30.6 ± 2.0. A search was made for a γ-ray branch analogous to the 20% branch of the mirror level in ^{29}Si, 8.31 → 4.90 MeV. The limits on two branches suggested by known ^{29}P spin and parity assignments are 8.38 → 4.97, (25 ± 14)% and 8.38 → 5.30, <3.4% (2 standard deviations). Angular distributions were measured for the 8.38 → 1.38, 8.38 → 1.95, and 8.38 → 2.42 transitions; the analysis of these distributions restricts J(8.38) to ⅜ or ⅝, and provides γ-ray multipole-mixing ratios. The radiative decay of this level is compared with the radiative decay of the mirror level in the conjugate nucleus, ^{29}Si. Incidental measurements were made of the energies of the second and third excited states in ^{29}P: E_x (keV) = 1950.0 ± 1.3 and 2421.7 ± 1.3, respectively. The excitation energy of the T = ½ level was found to be E_x = 8382.1 ± 2.8 keV. (5 figures, 4 tables) (auth)

29570 ELECTROMAGNETIC TRANSITION RATES IN ^{28}Al. Maher, J. V. (Argonne National Lab., Ill.); Beard, G. B.; Wedbergs, G. H.; (and others). Phys. Rev., C; 5: No. 4, 1322-9 (Apr 1972).

Lifetimes for the 2nd through 12th excited states in ^{28}Al were obtained by use of the attenuated-Doppler-shift technique. Combining these results with previous information on this nucleus makes it possible to assign spins to all of the states that were studied. All of the information is then compared with a shell-model calculation and with other theoretical descriptions that have been advanced. (3 figures, 2 tables) (auth)

29571 REACTION $^{38}Ar(d,p)^{39}Ar$. Sen, S.; Hollas, C. L.; Bjork, C. W.; Riley, P. J. (Univ. of Texas, Austin). Phys. Rev., C; 5: No. 4, 1278-88(Apr 1972).

The level structure of ^{39}Ar was investigated via the stripping reaction $^{38}Ar(d,p)^{39}Ar$ at an incident deuteron energy of 10.064 MeV with an over-all experimental resolution of approximately 35 keV. Proton groups leading to 44 states of ^{39}Ar with excitation energies up to 7.727 MeV were identified. Thirty of these states with excitation energies up to 6.488 MeV are neutron bound. The orbital-angular-momentum-transfer values and the spectroscopic factors were extracted for 28 of the observed neutron-bound states by using zero-range distorted-wave Born-approximation (DWBA) calculations corrected for nonlocality of the optical potential and finite range in the local-energy approximation. One l = 0, one l = 2, twelve l = 3, and fourteen l = 1 transfer values were assigned. Spin assignments were made on the basis of the conventional shell-model ordering of states, by comparison with the level structure of the isotonic nucleus ^{41}Ca in the reaction $^{40}Ca(d,p)^{41}Ca$, and on the basis of the Lee–Schiffer effect. It is found that the conventional DWBA calculation with spin–orbit coupling reproduces the observed Lee–Schiffer effect for l = 1 states remarkably well. The results of the present investigation are in fair agreement with those of recent shell-model calculations. (6 figures, 3 tables) (auth)

29572 MEASUREMENT OF NEUTRON POLARIZATION FROM (d,n) REACTIONS ON ^{24}Mg, ^{28}Si, AND ^{40}Ca AND COMPARISON TO DWBA CALCULATIONS. Taylor, J.; Stammbach, Th.; Spalek, G.; Walter, R. L. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.). Nucl. Phys.; A186: No. 1, 33-48(1972).

Angular distributions of the neutron polarization produced in (d,n) reactions on ^{24}Mg and ^{28}Si were obtained in about 300 keV steps from 3.9 MeV down to 2.2 and 2.9 MeV, respectively. Excitation functions of the polarization were measured at 20° and 40° (lab) over these energy ranges. Polarization angular distributions were also measured for (d,n) reactions on ^{28}Si at 8.1 MeV and ^{40}Ca at 3.8 MeV. DWBA calculations are compared to the latter distributions as well as to the (d,n) cross-section data. Fluctuations in the low-energy polarization data from the ^{24}Mg and ^{28}Si targets made DWBA comparison of questionable value. (auth)

29573 MEASUREMENT OF CROSS SECTIONS OF NUCLEAR REACTIONS FOR 14-MeV-NEUTRONS BY THE ACTIVATION METHOD. Mogharrab, R.; Neuert, H. (Univ., Hamburg). Atomkernenergie; 19: No. 2, 107-10(Apr 1972). (In German).

The nuclear reactions $^{27}Al(n,p)^{27}Mg$, $^{63}Cu(n,2n)^{62}Cu$, $^{65}Cu(n,2n)^{64}Cu$, $^{19}F(n,2n)^{18}F$, and $^{181}Ta(n,2n)^{180m}Ta$ have been studied for 14-

MeV-neutrons by means of β-radiation counting of the formed radioactive isotopes. The simultaneous observed reaction $^{27}Al(n,\alpha)^{24}Na$, which is known from measurements by Vonach et al. [1] with high accuracy, was used for comparison in order to keep the errors of the measurements small. The cross sections were found to be 68.6 ± 1.4 mb, 442 ± 8 mb, 882 ± 20 mb, 41.8 ± 0.9 mb, and 2074 ± 47 mb, respectively. (auth)

29574 USE OF THE (^{7}Li,^{7}Be) REACTION TO MEASURE THE MASS OF ^{26}Na. Ball, G. C.; Davies, W. G.; Forster, J. S.; Hardy, J. C. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev. Lett.; 28: No. 16, 1069-71(17 Apr 1972).

The reaction $^{26}Mg(^7Li,^7Be)^{26}Na$ at $E(^7Li) = 36$ MeV has been used to measure the mass excess of ^{26}Na; a value of -6.853 ± 0.030 MeV was obtained. This result differs by 0.3–0.8 MeV from those previously determined from β-decay end-point measurements. (auth)

29575 STUDY OF THE $^{31}P(p,\gamma)^{32}S$ REACTION AND THE EXCITED STATES OF ^{32}S. Coetzee, W. F.; Meyer, M. A.; Reitmann, D. (Potchefstroom Univ., South Africa). Nucl. Phys., A185: No. 2, 644-68(1972).

Proton energies and strengths of resonances of the $^{31}P(p,\gamma)^{32}S$ reaction were determined for $E_p < 2$ MeV. The γ-decay of 35 resonances was studied by means of a 40 cm^3 Ge(Li) detector. The Q-value of this reaction and the energies, branching ratios and mean lifetimes of bound levels were determined. The spins of the $E_x = 6.62$, 10.26, and 10.40 MeV levels were found to be $J = 4$ from angular distribution measurements. The present results are compared with previous measurements. Some γ-ray transition strengths have been calculated and compared with various models. (auth)

29576 RESONANCE LEVELS IN ^{28}Si FROM ^{27}Al + p REACTIONS. Tveter, A. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Nucl. Phys.; A185: No. 2, 433-58(1972).

By measuring the proton elastic scattering from ^{27}Al with surface barrier detectors, 18 resonance levels in ^{28}Si were observed in the energy range $E_p = 1.1-1.8$ MeV. For all resonances, the proton orbital momenta were determined, and for 12 resonances unique spin assignments were made on the basis of these and previous (p,γ) and (p,α) measurements. Partial proton widths are given for all resonances. The yield of inelastically scattered protons from ^{27}Al and of the emitted α-particles to the first excited state in ^{24}Mg was also observed. Resonance strengths were determined relative to the known strength of the 1184 keV resonance in the $^{27}Al(p,\gamma)^{28}Si$ reaction. Seven resonances can be classified as probable analogs of the 3.46, 3.59, 3.67, 3.88, 3.93, and 4.03 MeV states in ^{28}Al. For all T = 1 resonances spectroscopic factors were deduced. (auth)

29577 NUCLEAR STRUCTURE STUDIES ON ^{29}Al. Hirko, R. G.; Lindgren, R. A.; Howard, A. J.; (and others) (Yale Univ., New Haven). Particles Nucl.; 1: No. 6, 372-90(Mar 1971).

The low levels of ^{29}Al were studied by means of charged-particle spectroscopy by using the $^{27}Al(t,p)^{29}Al$ reaction. Proton angular distributions characteristic of an l = 0 transfer were observed in the formation of the ^{29}Al ground state, the 3.07-MeV state, and also the unresolved 5.395- and 5.424-MeV states. In addition, particle–gamma angular correlation measurements were performed in a collinear geometry by using the $^{26}Mg(\alpha,p\gamma)^{29}Al$ reaction. De-excitation branching ratios as well as limitations on spins and mixing ratios are presented. These data, examined within the framework of the strong-coupling model of Nilsson, are consistent with an interpretation in which ^{29}Al is prolate in shape. (6 figures, 3 tables) (auth)

29578 LIFETIME MEASUREMENTS IN ^{27}Si. Hagen E. C. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.); Gould, C. R.; Roberson, N. R.; Tilley, D. R. Particles Nucl.; 3: No. 2, 92-104(Feb 1972).

Levels in ^{27}Si were populated with the $^{24}Mg(\alpha,n)^{27}Si$ reaction at $E_\alpha = 10.8$, 12.61, and 15.0 MeV. The decay γ rays were detected in coincidence with neutrons. From Doppler-shift-attenuation measurements, mean lifetimes (or limits) were obtained for six levels below $E_x = 3$ MeV. The transition strengths are compared with weak-coupling-model calculations. (6 figures, 3 tables) (auth)

29579 HIGH RESOLUTION SEARCH FOR THE $J^\pi = 0^+$ T = 1 LEVEL IN ^{26}Al NEAR 3.7 MeV. Bissinger, G. A. (Univ. of North Carolina, Chapel Hill. Triangle Universities Nuclear Lab., Durham, N. C.); Gould C. R. Particles Nucl.; 3: No. 2, 105-111 (Feb 1972).

The 3.72-MeV level in ^{26}Al was found to decay by γ-ray emission to the 0^+ level at 0.23 MeV. The 3.72-MeV level cannot, therefore, be the missing 0^+, T = 1 analog state in ^{26}Al, as reported in a recent publication. The 3.75-MeV level is found to be a doublet, however, the upper member of which may be this analog state. (2 figures, 1 table) (auth)

29580 NUCLEAR AND COULOMB PAIRING ENERGY SYSTEMATICS IN LIGHT NUCLEI. Walker, G. E. (Indiana Univ., Bloomington. Stanford Univ., Calif. Los Alamos Scientific Lab., N. Mex.); Stokes, Richard H. Particles Nucl.; 3: No. 1, 1-27(Jan 1972).

A study of the regularities in the nuclear and the Coulomb pairing energies was made for nuclei through the $f_{\frac{7}{2}}$ shell. Compilations using ground-state mass data show two types of pronounced systematic behavior. This behavior is investigated with several theoretical models which give insight into the mechanisms involved and which allow extrapolation to be made with confidence. These ideas were applied to make predictions concerning the ground-state masses of selected proton- or neutron-rich nuclides. Most of these nuclides are predicted to be stable or nearly stable to nucleon decay and are, therefore, attractive subjects for future investigations. (1 figure, 6 tables) (auth)

29581 STUDY OF THE $^{23}Na(p,\gamma)^{24}Mg$ REACTION AND THE EXCITED STATES OF ^{24}Mg. Meyer, M. A.; Reinecke, J. P. L.; Reitmann, D. (Potchefstroom Univ., South Africa). Nucl. Phys.; A185: No. 2, 625-43(1972).

Proton energies and strengths of (p,γ), (p,p_1) and (p,α_1) resonances of the ^{23}Na + p reaction were determined for $E_p = 1-2$ MeV. The γ-decay of 25 resonances in the energy range $E_p = 0.3-2.0$ MeV was studied by means of a 40 cm^3 Ge(Li) detector. The Q-value of the $^{23}Na(p,\gamma)^{24}Mg$ reaction was found to be Q = 11691.2 ± 1.1 keV. The energies and branching ratios of 32 bound levels and the lifetimes of 18 bound levels were determined. The γ-ray transition strengths have been calculated and compared with various models. (auth)

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Refer also to abstracts 29304, 29514, 29520, 29532, 29549, 29560, 29571, 29572, 29580, 29613, 29620, 29626, 29649, 29651, 29699, 29720, 29759, 29769, 29774, and 29839.

29582 (JEN–216-IFIC/I-3) LEVEL SCHEME OF ^{56}Mn AND ANGULAR DISTRIBUTION OF THE $^{55}Mn(d,p)^{56}Mn$ REACTION. Lopez Garcia, A. (Junta de Energia Nuclear, Madrid (Spain)). 1970. 17p. (In Spanish). Dep. NTIS (U. S. Sales Only).

The energy spectra of the protons emitted from a manganese target bombarded with 10.1-MeV deuterons were measured at 24 angles between 5 and 175 with a multi-angle magnetic spectrograph, with a resolution of about 20 keV. A total of 165 proton groups were ascribed to levels of ^{56}Mn up to an excitation energy of 6 MeV; 65 of them were reported for the first time. The angular distributions of all these proton groups were also measured. Most of the proton groups exhibits strong forward maxima. The experimental distributions were fitted with Butler plane wave stripping curves, which enables the l-values assignments to be made. (auth)

29583 NUCLEAR REACTION STUDIES OF THE (d,pn), (p,pn), AND (p,2p) REACTIONS BY MEANS OF A COINCIDENCE TECHNIQUE. Fink, Charles Lloyd. Pittsburgh; Univ. of Pittsburgh (1971). 126p. University Microfilms Order No. 72-7579

Thesis.

In a previous study of the (d,pn) reaction, Nemets et al., have suggested that deuteron breakup by heavy nuclei may be appreciably different in closed-shell nuclei from that on neighboring non-closed shell nuclei. Their experimental evidence, based on measurements at 13.6 MeV in the Ca–Ni region, has been reinvestigated with a more favorable experimental arrangement. It was found that (d,p) reactions followed by neutron emission and (d,n) reactions followed by proton emission are responsible for a large fraction of the events. Since these additional processes appear to account for most of the observed differences, there is no good evidence for the effect in this region. However, a study on ^{208}Pb, ^{209}Bi, ^{197}Au and ^{198}Pt using 17- and 14.5 MeV deuterons revealed a large difference, with the closed-shell nucleus, ^{208}Pb, having a cross section 1.2 to 2.5 times larger than the others. Since this effect cannot be explained if the breakup occurs because of Coulomb forces, nuclear forces must contribute strongly. From this, it is deduced that the usual method for determining the radius at which breakup occurs is invalid. The (p,2p) reaction was studied at an incident energy of 17-MeV for 8 different nuclei in the Ni region. Since the measurement of the proton energy spectrum in one detector showed that the (p,2p) reaction proceeds via a (p,p′) reaction followed by a proton boil-off, the experimental results

were analyzed by assuming the (p,p′) reaction proceeds via a compound nucleus and that the subsequent proton boil-off is governed by statistical theory. The results for the proton–proton and proton–neutron competition were in substantial agreement with the theoretical predictions for the even–even nuclei studied. The single exception was ^{54}Fe where the usual spin cut-off parameter had to be increased by a factor of 1.7. The agreement between experiment and theory for the odd-even nuclei was not as good because of large contributions to the inelastic scattering from direct reactions. Reasonable agreement could still be obtained, however, by assuming a different spin distribution for those states from which the second proton is emitted. In addition to the proton–nucleon competition, a study was also made of the proton–gamma competition. The observed competition could be explained only if a Porter–Thomas distribution of widths was used for the proton widths. Total radiation widths were also measured and compared with the widths calculated from an extrapolation of the giant dipole resonance. (Diss. Abstr. Int., B)

29584 STUDY OF EXCITED STATES IN ^{49}V WITH THE ^{48}Ti(p,γ)^{49}V REACTION. Kiuru, A. (Univ. of Helsinki). Z. Phys.; 251: No. 2, 93-104(1972).

In the ^{48}Ti(p,γ)^{49}V reaction gamma decays of thirteen resonances between E_p = 960 and 1570 keV are investigated. Level energies within ±0.5 – ±2.0 keV and Q-value 6756.8 ± 1.5 keV are obtained. Branching ratios for the resonance states and strongly populated bound states are given. Gamma-ray angular distribution measurements yield the following J(keV) assignments of ^{49}V bound and resonance states: J(1140) = $\frac{5}{2}$, J^π(2235) = $\frac{1}{2}^{(-)}$, J(2264) = $(\frac{3}{2})$, J(2308) = $\frac{3}{2}$, J(3912) = $\frac{3}{2}$, J(8105, E_p = 1374 keV) = $(\frac{1}{2})$ and J^π(8289, E_p = 1564 keV) = $\frac{1}{2}^{(-)}$. Multipolarity mixing ratios for all measured primary and secondary gamma rays are tabulated. Doppler-shift attenuation measurements yield the mean lifetimes τ_m(keV) of the following bound states in ^{49}V: $\tau_m(748) = \left(200 \pm \frac{400}{100}\right)$ fs, $\tau_m(1140) = \left(250 \pm \frac{500}{100}\right)$ fs, $\tau_m(1155) >$ 400 fs, $\tau_m(1515) = \left(45 \pm \frac{30}{20}\right)$ fs, $\tau_m(1644) = \left(55 \pm \frac{30}{20}\right)$ fs, $\tau_m(1661) =$ (25 ± 5) fs, $\tau_m(1994) >$ 400 fs, $\tau_m(2235) = \left(30 \pm \frac{30}{15}\right)$ fs, $\tau_m(2264) = \left(45 \pm \frac{30}{15}\right)$ fs and $\tau_m(2308) =$ (20 ± 10) fs. (auth)

29585 CAPTURE OF 10 TO 100 keV NEUTRONS IN ISOTOPES OF TITANIUM. Broomhall, G. J. (Univ. of Melbourne). Aust. J. Phys.; 25: No. 1, 9-19(Feb 1972).

Gamma-ray spectra are presented as functions of neutron energy for capture of 10-to-100-keV neutrons in natural titanium. The spectra are dominated by transitions to the first, third, and fifth excited states of ^{49}Ti which show strong fluctuations with neutron energy. The nature of these fluctuations and their relation to the nature of the capture process are discussed. A small but measurable strength in the transition to the $\frac{7}{2}^-$ groundstate of ^{49}Ti has been observed, and this is interpreted as evidence for the existence of a d-wave resonance in the reaction ^{48}Ti(n,γ)^{49}Ti at 39 keV. Transitions at 8260 and 8380 keV are assigned to capture in ^{47}Ti. (auth) (Australia)

29586 ELASTIC SCATTERING OF PROTONS BY ISOTOPES OF CHROMIUM AND VANADIUM. Romanovskii, E. A.; Spasskii, A. V.; Spasskaya, T. I.; Teplov, I. B. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 4, 398-401(Jul-Aug 1971). (In Russian).

The angular and energy dependence of proton scattering at 2.8 to 6.3 MeV was determined for elastic scattering by the following nuclei: ^{50}Cr, ^{52}Cr, ^{53}Cr, ^{54}Cr, and ^{51}V. (3 figures) (tr-auth)

29587 SOME STUDIES OF THE EFFECTIVE INTERACTION FOR INELASTIC ALPHA SCATTERING. Satchler, G. R. (Oak Ridge National Lab., Tenn. Nuclear Physics Lab., Oxford). Particles Nucl.; 2: No. 5, 265-84(Nov 1971).

Some "microscopic" calculations of inelastic alpha scattering are presented, both with a folded interaction plus some estimate of exchange effects and with a Gaussian approximation to a phenomenological interaction obtained from nucleon–alpha scattering. The former gives agreement with measurements on the 3^- excitations of ^{40}Ca and ^{208}Pb but fails for the 5^- in ^{40}Ca. The latter interaction is too weak. (10 figures, 4 tables, 42 references) (auth)

29588 ISOBARIC ANALOGS OF ^{41}Ar LEVELS OBSERVED THROUGH THE REACTION ^{40}Ar(p,p′γ)^{40}Ar. Buerger, K. H. Jr.; Place, R. L.; Wakatsuki, T.; Kern, B. D. (Univ. of Kentucky, Lexington). Phys. Rev., C; 5: No. 4, 1295-1304(Apr 1972).

Resonances in the reaction ^{40}Ar(p,p′)^{40}Ar from 3.35 to 5.21 MeV were studied through the acquisition of proton excitation functions, proton angular distributions, and p′–γ angular correlations. Analysis was accomplished with a simple single-resonance model in which the compound-nucleus formation is incoherent with direct-interaction effects. Most of the six resonances which were analyzed had $J^\pi = \frac{3}{2}^-$; one had $J^\pi = \frac{5}{2}^+$. These resonant levels of ^{41}K are interpreted as being isobaric analogs of levels of the parent nucleus ^{41}Ar and are identified with known levels resulting from the reaction ^{40}Ar(d,p)^{41}Ar. The decay of the $\frac{3}{2}^-$ resonances to the 2^+ 1461-keV excited level of ^{40}Ar occurs with mixing of $p_{\frac{3}{2}}$ and $p_{\frac{1}{2}}$ waves. Spectroscopic factors for each partial wave were calculated. 97% of the $[(p_{\frac{3}{2}})_n{}^{40}\text{Ar}(2^+)]$ strength in the parent ^{41}Ar was identified. The $\frac{5}{2}^+$ resonance decays to the 1461-keV 2_1^+ level by means of an $s_{\frac{1}{2}}$ wave, this finding indicating the presence of a proton wave-function component in ^{40}Ar of the form $(s_{\frac{1}{2}}^{-1}d_{\frac{5}{2}}^{-2}d_{\frac{3}{2}})_{\frac{1}{2}}$. (11 figures, 1 table) (auth)

29589 STRONGLY EXCITED 1^+ STATES IN THE REACTIONS ^{46,48}Ca(^{3}He,p)^{48,50}Sc. Fleming, D. G. (Univ. of Copenhagen); Broglia, R. A.; Abdo, K.; (and others). Phys. Rev., C; 5: No. 4, 1356-65(Apr 1972).

Several new 1^+ states in ^{48,50}Sc were identified in the (^{3}He,p) reaction. From distorted-wave (DW) calculations, it appears that the total 1^+ strength of ^{50}Sc, relative to the strength of the $(f_{\frac{7}{2}}p_{\frac{3}{2}})$ 5^+ ground state, is about a factor of 3 larger than predicted by calculations within the 1f–2p configuration space. In ^{50}Sc most of the 1^+ strength is concentrated in one state, whereas ^{48}Sc shows a strong fractionation effect. Such a large 1^+ strength in ^{50}Sc cannot be accounted for by existing nuclear-structure calculations. Provided the DW argument holds true, the large 1^+ strength may indicate a new feature in the spectroscopy of ^{48,50}Sc and possibly in other odd–odd nuclei in this mass region. (6 figures, 4 tables) (auth)

29590 FURTHER INVESTIGATION OF TWO-BODY INTERACTIONS IN HARTREE–FOCK CALCULATIONS. Reuben, Benjamin; Saunier, Gerard (Univ. of Montreal). Phys. Rev., C; 5: No. 4, 1223-33(Apr 1972).

Hartree–Fock calculations with two-body forces are presented in several nuclei, taken as spherical, from ^{4}He to ^{208}Pb. The results obtained with the best (SP1 and SP2) of the recent smooth semirealistic interactions of Saunier and Pearson are first presented. These yield good binding energies and radii except in the vicinity of ^{56}Ni. However, the spectra in nuclei with spin-unsaturated shells are poor: the spin–orbit splittings in such nuclei are very small (if not negative), and, in particular, in ^{208}Pb the level ordering near the top of the Fermi sea is incorrect. This feature does not allow meaningful extrapolation to the super-heavy region with these potentials. An attempt to find a two-body interaction allowing such an extrapolation by modifying SP1 reveals that with a very strong positive triplet-even phenomenological tensor force the ^{208}Pb spectrum is very much improved, and the level ordering and density of uppermost occupied states are comparable to the experimental ones. As a result, ^{208}Pb is now found doubly magic, together with a good binding energy and radius. The magic nature of ^{16}O, ^{40}Ca, ^{48}Ca, ^{56}Ni, and ^{90}Zi is also reproduced by the modified SP1. Consequently, this interaction provides new possibilities for valuable extrapolation to the superheavy region with a two-body force. (6 figures, 4 tables) (auth)

29591 ALPHA–GAMMA ANGULAR CORRELATIONS IN THE REACTION ^{40}Ca(d,αγ)^{38}K. Hasper, H.; Smith, Ph. B.; Smulders, P. J. M. (Univ., Groningen, Netherlands). Phys. Rev., C; 5: No. 4, 1261-70(Apr 1972).

Angular correlations of γ rays deexciting states in ^{38}K were measured. The reaction ^{40}Ca(d,αγ)^{38}K (E_d = 4.421 and 5.080 MeV) with θ_α near 180° was used to populate levels of ^{38}K. The decay of levels below an excitation energy of 3.7 MeV is given. Unique spin–parity assignments of 1^+, 1^+, and 2^+ could be made for the second, third, and fourth excited states. In addition, limitations could be imposed on spins and parities of seven other excited states. Multipole mixing ratios of the decay γ rays are given. Yield measurements, averaged over a large incident deuteron energy range, provided information on spin–parity assignments of two excited states. (12 figures, 1 table) (auth)

29592 NUCLEAR SPECTROSCOPY OF ^{48}Sc FROM THE ^{46}Ca(^{3}He,p) REACTION. Fleming, Donald G. (Univ. of Copenhagen); Nathan, Ove; Jensen, Hans B.; Hansen, Ole. Phys. Rev., C; 5: No. 4, 1365-75(Apr 1972).

The reaction ^{46}Ca(^{3}He,p)^{48}Sc was investigated at 18 MeV. Several new spectroscopic assignments were made for the states in ^{48}Sc up to an excitation energy of 7 MeV. The spectrum is dominated by 1^+, 2^+, and 3^+ states. The 1^+ to 7^+ members of the $(f_{\frac{7}{2}})^{-1}f_{\frac{7}{2}}$ multiplet are very weakly populated, and this result is consistent with distorted-wave Born-approximation calculations based on such a model. The presence of configuration mixing in the low-spin members of the multiplet is deduced from a distorted-wave analysis of the cross sections; in particular, the

6.685-MeV 0^+, T = 4 state (the analog of the ^{48}Ca ground state) was found to be populated about 5 times more strongly than predicted by the simple $(f_{\frac{7}{2}})^{-1}f_{\frac{7}{2}}$ model. This enhancement factor is similar to the one found in the reaction ^{46}Ca(t,p)^{48}Ca(g.s.), and can be explained in terms of small admixtures of 2s−1d hole components in the ^{46}Ca ground-state and of 2p−1f configurations in the ^{48}Ca ground-state wave functions. (8 figures, 5 tables) (auth)

29593 s- AND p-WAVE NEUTRON SPECTROSCOPY. PART Xa. INTERMEDIATE STRUCTURE, 2p–1h STATES. Divadeenam, M. (North Carolina Central Univ., Durham. Triangle Universities Nuclear Lab., Durham, N. C.); Beres, W. P.; Newson, H. W. Ann. Phys. (N. Y.); 69: No. 2, 428-50(Feb 1972).

Feshbach, Kerman, and Lemmer's doorway-state theory of intermediate structure is applied to the investigation of neutron doorway escape widths, $\Gamma_d\downarrow$. The target nuclei in the ground states are assumed to be spherical in nature, and the three compound nuclei ^{91}Zr, ^{89}Sr, and ^{49}Ca are considered as test cases. A basis of 2p−1h states in each of the above three compound nuclei is diagonalized via an effective two-body interaction. Doorway states of various angular momenta and of both parities are considered for the nuclei under investigation. Throughout the entire calculation proper Woods–Saxon potentials are used to generate both the neutron and proton wave functions. In the case of ^{89}Sr and ^{91}Zr, the calculated p-wave escape widths are large compared to the s-wave widths in the low-energy region. This is a manifestation of the single-particle giant resonance phenomenon. The effect of shell closure is evident in ^{49}Ca in that the predicted spacing of levels is large; for instance, the lowest predicted s-wave doorway is about 1.5 MeV. For comparison with low-energy (En ≤ 1.4 MeV) neutron scattering data, the sum rule $\Sigma\gamma_n^2 = \gamma_d^2$ is employed, and the effect of doorway states on the local strength function and the fine structure observed is discussed. In general, it can be said that the calculations are consistent with all the available experimental data, which are not extensive enough to verify all the details of the calculations. For instance, it is only possible to conclude that the 2p−1h structure is an alternative representation of these doorway states, the other possibility being the excited core picture, which seems to be confirmed for Pb. (4 figures, 5 tables) (auth)

29594 HIGH RESOLUTION PROTON RESONANCE REACTIONS. Bilpuch, E. G. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.). pp 99-120 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

Excitation functions for proton elastic and inelastic scattering and (p,n) reactions on even-even nuclei in the 40 ≤ A ≤ 64 region have been measured at 1 to 3 MeV. The fine structure of over 40 analog resonances has been resolved. The information obtained from these studies is summarized. (J.W.R.)

29595 NUCLEAR SPECTROSCOPY UTILIZING AN (ALPHA, NUCLEON) RESONANCE REACTION. Sheldon, E.; Schier, W. A.; Couchell, G. P.; (and others) (Lowell Technological Inst., Mass.). pp 121-7 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The ^{31}P (α,p) ground-state excitation function was measured in 5-keV steps from 3.25 to 5.50 MeV. The compound-nucleus levels in ^{35}Cl at 9.9 to 11.9 MeV were studied. Systematic statistical trends were found which aided in making spin-parity assignments to overlapping twin states. The spin-parity assignments are discussed. (J.W.R.)

29596 CHANNEL CORRELATION EFFECTS FOR FRAGMENTED ANALOG STATES. Mitchell, G. E. (North Carolina State Univ., Raleigh. Triangle Universities Nuclear Lab., Durham, N. C.); Bilpuch, E. G.; Moses, J. D.; Peters, W. C.; Prochnow, N. H. pp 299-306 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

Some results illustrating the variety of channel correlation phenomena occurring in proton, neutron, and γ decays of fragmented analog states produced in proton reactions on ^{48}Ti, ^{54}Cr, and ^{64}Ni are presented. The reactions ^{48}Ti(p,p), ^{48}Ti(p,p'), ^{54}Cr (p,p), ^{54}Cr(p,γ), ^{54}Cr(p,n), ^{64}Ni(p,p), and ^{64}Ni(p,n) were studied for proton energies up to 3 MeV. Explanations are offered for the correlations which were found. (J.W.R.)

29597 INTERMEDIATE STRUCTURES IN THE NEUTRON SCATTERING CROSS SECTIONS OF IRON. Tomita, Y.; Tsukada, K.; Maruyama, M. (Japan Atomic Energy Research Inst., Tokai). pp 573-8 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

Intermediate structure observed at about 1.6 and 2.05 MeV in the differential cross sections for neutron elastic and inelastic scattering by iron is analyzed using a doorway-state model allowing for direct coupling between compound states and open channels. The best-fit parameters are listed. (J.W.R.)

29598 GROUND-STATE RADIATION WIDTHS FOR RESONANT STATES IN ^{57}Fe. Jackson, H. E.; Strait, E. N. (Argonne National Lab., Ill.). pp 601-10 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The cross section for ^{57}Fe(γ,n) reactions near threshold was measured with high resolution. Ground-state radiative widths for ^{57}Fe neutron resonances in the range 20 to 700 keV were extracted. (J.W.R.)

29599 PHOTODISINTEGRATION OF ^{40}Ca THROUGH PROTON CHANNELS. Brajnik, D.; Jamnik, D.; Kernel, G.; Miklavzic, U.; Stanovnik, A. (Josef Stefan Nuclear Inst., Ljubljana, Yugoslavia. Univ. of Ljubljana, Yugoslavia). Fizika (Zagreb); 4: No. 1, 65-8(Jan 1972).

Cross sections leading to different states in the residual nucleus were measured for the reaction ^{40}Ca(γ,p) at endpoint energies of 15.2 to 24.6 MeV, and the excitation functions obtained were compared with a 1p−1h coupled-channel shell-model calculation. It was concluded that the reaction was not quantitatively described by the calculation, impurities were indicated in the ground-state configuration of ^{40}Ca, and the measured photoproton cross sections have similar gross structure for all channels. (1 figure) (R.W.R.)

29600 NUCLEAR CHARGE DISTRIBUTIONS OF ISOTONES FROM ELECTRON SCATTERING: ^{31}P AND ^{32}S, AND ^{39}K AND ^{40}Ca. Sinha, Bidhu B. P. Amherst, Mass.; Univ. of Massachusetts (1971). 207p. University Microfilms Order No. 72-3749.

Thesis.

The Stanford Mark III linear electron accelerator and the associated apparatus were used to measure the differential elastic cross sections for the scattering of 250 to 400 MeV electrons from the isotones ^{31}P and ^{32}S, and of 150 to 497 MeV electrons from the isotones ^{39}K and ^{40}Ca. A momentum transfer range from 0.6 to 3.4 F^{-1} was spanned in measuring the isotones alternately in pairs at each angle of scattering. In order to obtain the predominant monopole cross sections of ^{31}P and ^{39}K, single-particle model calculations for higher multipole contributions were made. A partial-wave phase-shift analysis of the monopole cross sections in terms of a phenomenological modified Fermi charge distribution with a small modulated undulation gives an energy—independent fit to the entire range of measured cross sections. These phenomenological charge distributions were compared with the results of other electron scattering and muonic x-ray experiments, and with nuclear model calculations. Estimates of nuclear compressibility and nucleon density have been made. The difference of isotone charge as a function of nuclear radius shows prominent peaks and is compared with single $2s_{\frac{1}{2}}$ and $1d_{\frac{3}{2}}$ proton densities and with differences of shell model charge distributions. (Diss. Abstr. Int., B)

29601 ANGULAR CORRELATION STUDIES IN ^{54}Mn. Hill, Robert Elkin Jr. New Orleans; Tulane Univ. (1971). 127p. University Microfilms Order No. 72-3886.

Thesis.

The ^{54}Cr(p,nγ)^{54}Mn reaction was used to investigate the low-lying levels in ^{54}Mn. Targets of ^{54}Cr(94%) were bombarded with protons of energies between 2.1 and 3.2 MeV. The γ rays were observed with a 32 cm^3 Ge(Li) detector and a 7.6 cm × 7.6 cm NaI(Tl) detector. Gamma rays of energies (±0.5 keV) 55.1, 156.2, 211.0, 249.9, 351.5 and 406.4 keV are assigned as originating in ^{54}Mn. Threshold behavior for the γ rays coupled with coincidence measurements confirms the existence of levels at 55.1, 156.2, 367.2, and 406.4 keV. No firm evidence was found for a level at about 834 keV. The level at 367.2 keV had not previously been seen in the (p,nγ) reaction. Spin assignments of 3, 2, 4, 5, and 3 for the 0, 55.1, 156.2, 367.2, and 406.4 keV states respectively were deduced from γ angular distributions, γ,γ angular correlations and the measured branching ratios. (Diss. Abstr. Int., B)

29602 ^{56}Fe IN THE SEMI-MICROSCOPIC MODEL. Paar, V. (Univ. of Copenhagen. Inst. Rudjer Boskovic, Zagreb). Nucl. Phys.; A185: No. 2, 544-52(1972).

The properties of ^{56}Fe are investigated in the model of a two-proton hole cluster coupled to a quadrupole vibrational field in

^{58}Ni. The model is characterized by the coexistence of the quasi-vibrational and quasirotational structures. This general feature of the present approach is explored in the $f_{\frac{7}{2}}$ shell. (auth)

29603 PROTON–DEUTERON REACTIONS AT 40 MeV ON THE CALCIUM ISOTOPES. Martin, P.; Buenerd, M.; Dupont, Y.; Chabre, M. (Institut des Sciences Nucleaires, Grenoble, France). Nucl. Phys.; A185: No. 2, 465-87(1972).

The ^{40,42,44,48}Ca(p,d)^{39,41,43,47}Ca reactions have been studied at 40 MeV. Spectroscopic factors have been derived from a DWBA analysis using the effective binding-energy method or the separation-energy prescription with the radius as adjustable parameter. Both methods give very similar results. Analog states have been observed in all reactions. (auth)

29604 ACTIVATION CROSS SECTIONS, ISOMERIC CROSS-SECTION RATIOS, AND SYSTEMATICS OF (n,2n) REACTIONS AT 14 TO 15 MeV. Qaim, S. M. (Kernforschungsanlage, Juelich, Ger.). Nucl. Phys.; A185: No. 2, 614-24(1972).

Total cross sections for eighteen (n,2n) reactions at 14.7 ± 0.3 MeV in the medium- and heavy-mass regions have been measured by the activation technique using Ge(Li) detector γ-ray spectroscopy. Isomeric (n,2n) cross-section ratios were determined for ^{54}Fe, ^{92}Mo, ^{191}Ir, ^{198}Pt, and ^{198}Hg. A comparison of the experimental cross-section values with theoretical estimates based on the statistical model confirms that this reaction at 14–15 MeV proceeds mainly via compound nucleus formation. The dependence of the cross-section values on the relative neutron excess of the target nucleides and the systematic trends in these values are discussed in the light of the latest experimental data. No significant closed proton or neutron shell effects were discernible. (auth)

29605 COMPARISON OF THE CHARGE DISTRIBUTIONS OF THE TITANIUM ISOTOPES. Romberg, Edgar Frederick. College Park, Md.; Univ. of Maryland (1971). 159p. University Microfilms Order No. 72-4386.

Thesis.

Measurements were made of the elastic electron scattering from the three even isotopes of titanium, ^{46}Ti, ^{48}Ti, and ^{50}Ti, with the objective of determining the differences in their ground state charge distributions. The ratios of the elastic cross sections of the three isotopes were measured, thereby eliminating many of the uncertainties peculiar to an absolute cross section measurement. Theoretical calculations using a partial wave elastic scattering program showed that the ratios of cross sections arising from scattering from two slightly different Fermi type 2 parameter charge distributions depended strongly on the differences in the parameter describing the charge distribution but only weakly on the actual values of these parameters. These ratio curves, considered as a function of momentum transfer, achieved their extreme values at momenta transfer near 1.0 F^{-1}, which is near the point where the Born approximation form factor goes to zero. Therefore, ratios of cross sections were measured at momenta transfer ranging from 0.55 to 1.1 F^{-1} by holding the scattering angle fixed at 127.5° and varying the incident beam energy from 60 to 123 MeV. Since the isotopically enriched targets were not uniformly thick, a Cherenkov detector was used to count electrons forward scattered at 40°. Since the nuclear electron scattering cross sections are the same for all three isotopes at this angle, the count rate in the Cherenkov detector would be proportional to the effective target thickness under the beam spot. The experimental ratios were then fit by generating theoretical ratio curves corresponding to varying differences in the parameter of the charge distributions and calculating the chi-square for each one. The minimum chi-square resulting from this search procedure was not as low as expected due to the presence of additional systematic errors not included in the standard error bars assigned to each point. The change in the Fermi radius parameter is consistent with an $A^{\frac{1}{3}}$ variation from isotope to isotope, while the skin thickness parameter, Z, decreases sufficiently to cause a decrease in the rms charge radius, R, with increasing A. (Diss. Abstr. Int., B)

29606 ELASTIC NEUTRON SCATTERING FROM ^{40}Ca FOR NEUTRON ENERGIES TO 2 MeV. Nebe, J.; Kirouac, G. J. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys.; A185: No. 1, 113-30(1972).

Total and differential elastic neutron scattering cross sections for Ca are analyzed for resonance parameters below 2 MeV. A detailed reproduction of the total neutron cross section up to 1.2 MeV is given with multilevel R-matrix formulas. Using the theoretical expressions of Blatt and Biedenharn, shape features of the scattering data versus angle have been explored for spin and parity assignments. Strength functions and average level spacings are determined for s-, p-, and d-waves. Reduced widths and the R^{∞} coefficients have been obtained from the analysis. Using these quantities and the sum rules, the intermediate coupling picture of Lane, Thomas and Wigner is applied to the study of s-, p-, and d-wave strength in the energy region up to 2 MeV above the neutron threshold energy. (auth)

29607 GLOBAL OPTICAL-MODEL ANALYSIS OF 37.7 MeV ^{3}He ELASTIC SCATTERING FROM MEDIUM-A NUCLEI ($46 \leq A \leq 91$). Urone, P. P. (Rijksuniversteit, Groningen, Netherlands); Put, L. W.; Ridley, B. W. Nucl. Phys.; A186: No. 2, 344-52(1972).

Differential cross sections have been measured for the elastic scattering of 37.7-MeV ^{3}He particles by ^{46}Ti, ^{50}Ti, ^{51}V, ^{62}Ni, and ^{91}Zr. These data together with previously reported data on ^{48}Ti, ^{58}Fe, ^{58}Ni, and ^{90}Zr have been analyzed in terms of the optical model. Results of fits to the individual angular distributions are presented. The emphasis, however, is put on the results of global fits. Good fits are obtained by assuming that either all OM parameters or only the geometrical parameters are the same for each nucleus. These fits proved rather insensitive to dependencies of the well depths on isospin, asymmetry and energy. A preference for a surface-peaked imaginary potential rather than the usual volume shape has been observed throughout this study. (auth)

29608 PROPERTIES OF LOW LYING STATES OF ^{57}Ni. Bertin, M. C.; Hirko, R. G. (Stanford Univ., Calif.). Particles Nucl.; 1: No. 6, 359-71(Mar 1971).

The energies, decay modes, and mean lifetimes of the first five excited states of ^{57}Ni were determined using the ^{54}Fe(α,n)^{57}Ni reaction. The results are 768.5 ± 0.5 keV (>3 ps), 1112.4 ± 0.5 keV keV (220 ± 40 fs), 2443.1 ± 0.5 keV (48 ± 8 fs), 2577.4 ± 0.5 keV (78 ± 13 fs), and 3007 ± 1 keV (22 ± 11 fs). New spin information includes most probable assignments of J^{π}(2443 keV) = ($\frac{5}{2}^{-}$, $\frac{1}{2}^{-}$) and J^{π}(3007 keV) = ($\frac{3}{2}^{-}$, $\frac{5}{2}^{-}$). (6 figures, 3 tables) (auth)

29609 α-CLUSTER EFFECTS IN ELASTIC α SCATTERING FROM NUCLEI NEAR A = 40. Thompson, W. J. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Particles Nucl.; 2: No. 1, 47-55(Jul 1971).

The interpretation of anomalous backward peaking in elastic α scattering from some nuclei near A = 40 is re-examined. Target α clusters interacting with free α particles give partial-wave-dependent potentials; these, however, produce negligible effects in ^{40}Ca(α, α)^{40}Ca at 29 MeV, contrary to previous results. (4 figures) (auth)

29610 INTERFERENCE BETWEEN COULOMB AND NUCLEAR EXCITATION IN INELASTIC SCATTERING OF ^{16}O IONS. Videbaek, F.; Chernov, I.; Christensen, P. R.; Gross, E. E. (Univ. of Copenhagen). Phys. Rev. Lett.; 28: No. 16, 1072-4 (17 Apr 1972).

The excitation function for the process ^{58}Ni(^{16}O,^{16}O′)^{58}Ni* (1.45 MeV) has been measured at 60, 75, and 90° lab over the energy range 34–58 MeV. At low energy the cross section rises as expected from Coulomb excitation of an electric quadrupole with a B(E2) value of (0.066 ± 0.004)e^2 b^2. As the energy is increased further, the 2^+ excitation function exhibits a deep valley, due to an interference between Coulomb and nuclear excitations, which is localized over a distance of ~1 F and appears to be correlated with a rise in elastic scattering (relative to Rutherford scattering). (auth)

29611 REACTIONS INDUCED BY THE BOMBARDMENT OF ^{40}Ca WITH 70 MeV ^{16}O IONS. Watson, B. A.; Chang, C. C.; Tabor, S. L. (Stanford Univ., Calif.). Particles Nucl.; 2: No. 6, 376-87(Dec 1971).

An E–ΔE counter telescope, with E and ΔE counters separated by 80 cm, was used to detect the particles resulting from the bombardment of ^{40}Ca with 70-MeV ^{16}O. It is shown that the E–ΔE information combined with the time-of-flight between the two detectors offers a method for unique particle identification. Comparing the cross sections for the various transfer reactions reveals several interesting features: first, the cross sections exhibit an almost Gaussian behavior as a function of the number of particles transferred, stripping and pickup cross sections being about equal; second, the one- and two-alpha transfer reactions are two orders of magnitude stronger than the interpolated nonalpha transfer reactions; lastly, the ratio of cross sections leading to analog systems, for example, $\sigma(^{15}\text{O} + ^{41}\text{Ca})/\sigma(^{15}\text{N} + ^{41}\text{Sc})$, is approximately equal to 4 for the six pairs of reactions observed. (5 figures) (auth)

29612 ^{40}Ca(t,d$_0$)^{41}Ca REACTION NEAR THE COULOMB BARRIER. Goldfarb, L. J. B. (Univ. of Manchester, Eng.); Gonzalez, J. A.; Posner, M.; Jones, K. W. Nucl. Phys.; A185: No. 2, 337-48(1972).

Angular distributions of the ^{40}Ca(t,d$_0$)^{41}Ca reaction have been measured at energies near the Coulomb barrier at 2.0, 2.5, 3.0 and 3.5 MeV. A DWBA analysis of the data gives a value of the spectroscopic factor of 0.80 ± 0.03, in good agreement with the results of ^{40}Ca(d,p$_0$)^{41}Ca experiments. The sensitivity of the

result to variations in the optical-model parameters and bound-state neutron radius is discussed. (auth)

Nuclear Properties and Reactions, 59 ≤ A ≤ 89

Refer also to abstracts 27967, 29169, 29520, 29560, 29573, 29593, 29594, 29604, 29607, 29640, 29649, 29665, 29769, 29830, and 29833.

29613 (JAERI-1207) EVALUATION OF SOME FAST NEUTRON CROSS SECTION DATA. Kanda, Yukinori; Nakasima, Ryuzo (Japan Atomic Energy Research Inst., Tokyo). 27 Jul 1971. 20p. Dep. NTIS (U. S. Sales Only).

Cross section evaluations for $^{27}Al(n,\alpha)$, $^{56}Fe(n,p)$, $^{63}Cu(n,2n)$ and $^{65}Cu(n,2n)$ reactions, which are often adopted as standards in fast neutron experiments, are presented. Data from some fifty papers reporting excitation functions and individual experimental points are averaged by a computer procedure. Information on input values is summarized in a table. Output values are displayed in a table and on graphs which also contain experimental points for comparison. The neutron energy range is from threshold to ≈20 MeV. The literature is covered to the end of 1967. Values reported in 1968 and 1969 are discussed. (auth)

29614 CONTRIBUTIONS TO THE LEVEL SCHEMES OF ^{71}Ge, ^{73}Ge, ^{74}Ge, AND ^{75}Ge FROM A STUDY OF THE (n,γ) REACTION WITH NATURAL GERMANIUM. Weishaupt, Rainer; Rabenstein, Dietrich (Technische Univ., Munich). Z. Phys.; 251: No. 2, 105-34(1972). (In German).

Low energy γ-spectra from neutron capture in natural germanium have been studied with several high resolution Ge(Li) detectors. Measurements have been made with two different target configurations. In the first measurement a normal Ge-target was irradiated with neutrons; no neutrons were allowed to enter the Ge(Li)-detector. In the second measurement the Ge(Li)-detector was used simultaneously as target and as γ- and e^--detector. By combination of the results conversion coefficients of several transitions in ^{73}Ge have been determined. Several unknown low energy transitions in Ge isotopes have been found with the aid of the second method. The level schemes of ^{71}Ge, ^{73}Ge, ^{74}Ge and ^{75}Ge have been revised by means of coincidence measurements with a Ge(Li)-Ge(Li)-coincidence system of high efficiency and resolution. (auth)

29615 INVESTIGATION OF THE ^{60}Co AND ^{62}Co NUCLEI BY TWO-PARTICLE TRANSFER REACTIONS. II. ^{62}Co. Bachner, D.; Kelleter, H.; Schmidt, B.; Seliger, W. (Univ., Bonn). Nucl. Phys.; A184: No. 2, 609-14(1972).

Spectroscopic data on ^{62}Co are given. Until now only the existence of a ground state doublet has been known and assumptions regarding the spin assignments have been made. By means of the (d,α) reaction performed with 15-MeV deuterons on the ^{64}Ni target nucleus excitation energies up to about 2.8 MeV as well as spins of several levels were determined. Estimates about the configurations of the strongly excited levels were made. A possible correction to the only roughly known Q-value is suggested. (auth)

29616 INVESTIGATION OF THE ^{60}Co AND ^{62}Co NUCLEI BY TWO-PARTICLE TRANSFER REACTIONS. I. ^{60}Co. Seliger, W.; Bachner, D.; Kelleter, H.; Schmidt, B. (Univ., Bonn). Nucl. Phys.; A184: No. 2, 599-608(1972).

In order to obtain additional information about the ^{60}Co nucleus, the reactions $^{62}Ni(d,\alpha)$ and $^{58}Fe(^3He,p)$ both leading to the same final nucleus ^{60}Co were studied. The bombarding energies were 15 MeV and 12 MeV, respectively. Excitation energies up to about 4 MeV were measured and angular distributions for both reactions were analyzed by means of DWBA calculations. A large number of angular momenta could be extracted. In some cases information concerning the configurations could be obtained. (auth)

29617 STATES OF ^{87}Sr POPULATED BY DEUTERON PICK-UP FROM ^{89}Y. Brien, M.; Kitching, J. E.; Lee, J. K. P.; Hinrichsen, P. F. (McGill Univ., Montreal). Nucl. Phys.; A185: No. 1, 289-302(1972).

The reaction $^{89}Y(d,\alpha)^{87}Sr$ has been observed at a bombarding energy of 12 MeV. Angular distributions of the emitted α-groups were recorded over the angular range 10° to 160° lab and compared with a DWBA analysis. Many levels in ^{87}Sr appear to be populated by proton pickup from the $2p_{\frac{1}{2}}$ orbit. The levels of ^{87}Sr populated in this reaction correspond to those observed in the $^{87}Rh(p,n)^{87}Sr$ reaction but differ to a large extent from those seen in neutron stripping and pick-up reactions. (auth)

29618 RESIDUAL EFFECTS IN ^{84}Rb, ^{85}Sr, ^{87}Y, ^{86}Y, AND ^{85}Y DURING THE DE-EXCITATION OF THE COMPOUND NUCLEUS. Demeyer, A.; Chevarier, N.; Chevarier, A.; Pertosa, P.; Tran Minh Duc (Univ. Lyon, Villeurbanne, France). J. Phys. (Paris); 32: No. 11, 841-7(Nov-Dec 1971). (In French).

The isomeric ratios of ^{84}Rb, ^{85}Sr, ^{85}Y, ^{86}Y and ^{87}Y nuclei produced by the (n,2n) and (d,2n) reactions with ^{85}Rb and ^{86}Sr, the (d,3n) reaction with ^{88}Sr, and the (α,n) reaction with ^{81}Br were studied. The results obtained by other works were also used. The ratios obtained are compared with predictions made using the Fermi gas model. The spin distribution parameters were studied as a function of excitation energy and the nuclear structure. (France)

29619 DECAY OF ^{65}Zn. De Roost, E.; Funck, E.; Spernol, A.; Vaninbroukx, R. (EURATOM, Geel, Belgium). Z. Phys.; 250: No. 5, 395-412(1972).

The branching ratios in ^{65}Zn decay were reinvestigated using several precision methods. The ratios of the γ-emission rate to the total decay rate and of the β^+-emission rate to the total decay rate were determined to be 0.5075 ± 0.0010 and 0.0146 ± 0.0002, respectively. A value of (244.0 ± 0.2)d was found for the half-life. All cited errors are estimated to correspond to a confidence level of 68%. (auth)

29620 ELECTRON SCATTERING FROM ONE- AND TWO-PHONON VIBRATIONAL STATES. Lightbody, J. W. Jr. (National Bureau of Standards, Washington, D. C.). Phys. Lett.; 38B: No. 7, 475-9(3 Apr 1972).

Admixtures of one- and two-phonon states are required to fit (e,e′) form factors for the lowest two 2^+ states in several even-even vibrational nuclei. These anharmonic wave functions correctly reproduce radiative branching ratios and excited-state quadrupole moments. (auth)

29621 THERMAL-NEUTRON CAPTURE CROSS SECTION AND RESONANCE INTEGRAL FOR 10.7-YEAR ^{85}Kr. Bemis, C. E. Jr.; Druschel, R. E.; Halperin, J.; Walton, J. R. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng.; 47: No. 3, 371-2(Mar 1972).

The thermal-neutron capture cross section and capture resonance integral for 10.7-year ^{85}Kr were determined in carefully monitored experiments using 99.992% isotopically pure ^{85}Kr. Values of 1.66 ± 0.20 b and 1.8 ± 1.0 b for the thermal-neutron cross section and resonance integral, respectively, were derived from the increase in ^{86}Kr produced during the irradiation and measured mass spectrometrically. It was concluded from the results that the burnup of radioactive ^{85}Kr in power reactors as a possible means of disposal is not feasible. (auth)

29622 DECAY PROPERTIES OF NUCLEAR LEVELS POPULATED BY THE (γ,γ') REACTION. Moreh, R.; Wolf, A. (Nuclear Research Centre-Negev, Beer Sheva, Israel). pp 257-62 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

Some evidence for doorway state components in levels populated by (γ,γ') reactions is presented. Neutron capture γ rays were scattered from ^{62}Ni, ^{66}Zn, ^{75}As, ^{112}Cd, ^{120}Sn, and ^{150}Sm. Correlations between (d,p) and (γ,γ') reaction widths to the same final states were found. (J.W.R.)

29623 STRUCTURE IN THE (n,n′) CROSS SECTIONS OF Se ISOTOPES. Konobeevskii, E. S.; Musaelyan, R. M.; Popov, V. I.; Surkova, I. V. (Inst. for Nuclear Research, Moscow). pp 359-65 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

Excitation functions for neutron inelastic scattering from the first 2^+ states in $^{76,78,80,82}Sc$ were measured from threshold up to 1.5 MeV energies. The cross sections are considerably higher than theoretical results based on the optical model and statistical assumptions. The strong effects of channel coupling are discussed in connection with this discrepancy. (J.W.R.)

29624 COMPOUND NUCLEAR LIFETIMES FROM BLOCKING EXPERIMENTS IN Ge AND Mo. Clark, G. J. (Atomic Energy Research Establishment, Harwell, Eng.); Fuschini, E.; Maroni, C.; (and others). pp 535-42 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

Compound nuclear lifetimes of $^{71,73}As$ and ^{93}Tc from proton inelastic scattering by $^{70,72}Ge$ and ^{92}Mo were measured using the blocking effect. Level densities were deduced and compared with values deduced from semi-empirical calculations and fast neutron data. (J.W.R.)

29625 EVIDENCE FOR INTERMEDIATE STRUCTURE NEAR AN ISOBARIC ANALOGUE RESONANCE. Temmer, G. M.; Maruyama, M.; Mingay, D. W.; Petrascu, M.; Van Bree, R. (Rutgers–The State Univ., New Brunswick, N. J.). pp 563-72 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

In an investigation of the elastic and inelastic scattering of protons on separated isotopes of ^{70}Ge and ^{72}Ge for the purpose of locating isobaric analog states of ^{71}Ge and ^{73}Ge in ^{71}As and ^{73}As, respectively, one l = 0 resonance in each isotope, displaying pronounced structure within their "widths" was found. Evidence is presented that this structure is intermediate between the gross analog resonance structure on the one hand, and the ultimate compound-nucleus fine structure on the other hand. It is also argued that these structures are not Ericson fluctuations. (auth)

29626 HIGH-RESOLUTION STUDY OF ^{58}Co BY (d,α) AND (^{3}He,d) REACTIONS. Schneider, M. J.; Daehnick, W. W. (Univ. of Pittsburgh). Phys. Rev., C; 5: No. 4, 1330-50(Apr 1972).

Levels of ^{58}Co up to 4.1 MeV excitation were investigated by studying ^{60}Ni(d,α)^{58}Co at 17 MeV and the reactions ^{57}Fe(^{3}He,d) and ^{59}Co(^{3}He,α) at 18 MeV bombarding energy at the University of Pittsburgh Van de Graaff accelerator. Angular distributions up to 80 and 45°, respectively, for the first two reactions were taken with position-sensitive counters and nuclear emulsions in the focal plane of the Enge split-pole spectrograph. Typical experimental resolutions were 9 to 14 keV. Angular distributions for over 110 levels were compared with distorted-wave Born-approximation calculations in order to extract orbital angular momentum transfers. Optical-model well parameters satisfying the "well-matching" condition gave improved agreement of (d,α) calculations with experimental angular distributions. Spectroscopic factors were obtained for seventy ^{57}Fe(^{3}He,d)^{58}Co transitions. J^π assignments are given for nine levels; and J^π suggestions or limits, for a total of 88 levels. Some low-lying ^{58}Co levels can be described as ^{56}Co* plus a "spectator" neutron pair. Comparison with shell-model calculations of McGrory suggests that noticeable $(\pi f_{\frac{7}{2}}^{-1}, \nu f_{\frac{7}{2}}^{-1})$ strength appears in the ^{58}Co spectrum for 4^+ states at around 500 keV of excitation. About 11 states predicted by McGrory could be identified with those seen experimentally. (11 figures, 3 tables) (auth)

29627 DIFFERENTIAL-RANGE STUDY OF THE ^{65}Cu(^{3}He,α) REACTION AT 32 MeV. Chang, S. K.; Porile, N. T. (Purdue Univ., Lafayette, Ind.). Phys. Rev., C; 5: No. 4, 1247-52(Apr 1972).

The differential ranges of ^{64}Cu recoils emitted at 0 to 12° and 35 to 46° to the beam were measured for the ^{65}Cu(^{3}He,α) reaction at 32 MeV by means of the electrostatic-collection technique. The results were compared with a Monte Carlo evaporation calculation, as well as with a kinematic calculation for α-particle emission ascribable to a pickup process. The range at 0 to 12° is consistent with the evaporation of four single nucleons, and the contribution from pickup is less than 2%. The differential range at 35 to 46° consists of two well-resolved peaks whose positions are in accord with the expectations for these two mechanisms. The pickup process is found to account for (12 ± 2)% of the recoils emitted at this angle. (3 figures, 1 table) (auth)

29628 SPIN-WAVE EXCITATIONS IN ERBIUM. Holden, T. M.; Powell, B. M.; Stringfellow, M. W.; Woods, A. D. B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys.; 49: No. 23, 2875-85(1 Dec 1971). (AECL-4016).

Neutron scattering by spin waves in erbium at 4.6°K in its magnetic cone phase was measured along the c axis and to a lesser extent along lines parallel to the a axis. The results, when combined with assumptions about the crystal field interactions, lead to the spin-wave dispersion relation and the Fourier transform of the exchange interaction. Inconsistencies that arise from the crystal field (anisotropy) considerations lead to the conclusion that the model Hamiltonian on which the analysis is based is inadequate. Measurements of the temperature dependence of the scattering were also made. No well-defined spin-wave groups were observed in the more complex phase above 20°K. (auth)

29629 NUCLEAR DECAY SCHEME STUDIES USING RADIATIVE CAPTURE OF THERMAL NEUTRONS. Lewis III, John Wiley. Atlanta; Georgia Inst. of Tech. (1971). 78p. University Microfilms Order No. 72-5058.

Thesis.

Data from thermal neutron capture in ^{77}Se are reported and a decay scheme is presented for ^{78}Se based on this data and on information from previous charged-particle and radioactive decay work. The thermal capture facility consisted of a collimated, filtered external neutron beam with a flux of 4×10^6 n/cm^2-sec and a diameter of 1.25 cm. Ge(Li) detectors were used exclusively in both singles and coincidence gamma spectroscopy. In coincidence work data from two detectors were recorded in a multiparameter magnetic tape data acquisition system as a 4096 by 4096 channel array. A digital computer program sorted these data and produced spectra of those events in one detector that were in coincidence with gamma rays in a narrow energy region in the other detector. The energies of individual transitions were determined in singles runs. A linear sliding pulser was used to apply corrections for nonlinearity in the spectroscopy system. Both high- and low-energy gamma rays were observed in singles and coincidence spectra and a decay scheme for the low-lying levels of ^{78}Se was constructed. This decay scheme includes a previously unreported transition of 194.5 keV between the 0+, 4+ doublet of states at 1500 keV and the second excited 2+ state at 1308 keV. This transition is of theoretical interest because it is within the so-called two phonon triplet of vibrational levels. An ambiguity in the placement of the 768 keV transition in previous radiative capture work was resolved by the placement of this transition between the 2328 keV and 1500 keV levels. The assignment of a 1010.4 keV transition to ^{78}Se, as reported in earlier work, was not supported by the present data. (Diss. Abstr. Int., B)

29630 DECAY OF ^{68}Cu ISOMERS. Swindle, D. L.; Morcos, N. A.; Ward, T. E.; Meason, J. L. (Univ. of Arkansas, Fayetteville) Contract AT(40-1)-3235. Nucl. Phys.; A185: No. 2, 561-73(1972).

The decay of ^{68}Cu was studied by means of a Ge(Li) spectrometer and scintillation detectors. Several new β- and γ-rays were observed and coincidence relations were subsequently established. Five γ-rays attributed to the isomeric decay of ^{68m}Cu (3.8) min result from the deexcitation of an isomeric state at 721.4 keV to levels of 610.2 and 84.3 keV. The isomeric state is interpreted as a $J^\pi = 6^-$ state with a possible neutron-proton configuration of $(g_{\frac{7}{2}}^+)n, (p_{\frac{3}{2}}^-)p$. Approximately 85% of the decay is through isomeric transitions to the 31 sec ^{68}Cu ($J^\pi = 1^+$) ground state. This equilibrium activity was used to study the level structure of ^{68}Zn in addition to confirming previous assignments. (auth)

29631 COULOMB EXCITATION OF THE EXCITED 0^+ STATE IN ^{70}Ge. Simpson, J. J. (Univ. of Guelph, Ont.); Ward, D.; Ewan, G. T. Nucl. Phys.; A185: No. 2, 553-60(1972).

Measurements have been made of the yield of γ-rays following the Coulomb excitation of ^{70}Ge with ^{35}Cl ions at energies from 60 to 83 MeV and with ^{32}S ions at 75.7 MeV. A γ-ray of 175.9 ± 0.3 keV has been observed and has been associated with the decay of the excited 0_2^+ state in ^{70}Ge. A comparison of the yield of this γ-ray with the γ-ray de-exciting the 2_1^+ state of ^{70}Ge gives a $B(E2; 2_1^+ \rightarrow 0_2^+) = 0.0158 \pm 0.0024$ e$^2 \cdot$ b^2, in reasonable agreement with previous lifetime measurements but in disagreement with a previous Coulomb excitation result. An attempt has been made to observe Coulomb excitation of the second excited 2_2^+ state and thereby determine the latter's effect on the excitation of the 0_2^+ state. (auth)

29632 SINGLE-PROTON TRANSFER REACTIONS ON N = 50 NUCLEI. Harrison, J. F.; Hiebert, J. C. (Texas A and M Univ., College Station). Nucl. Phys.; A185: No. 2, 385-402(1972).

Deuterons accelerated to 30, 35.5, and 40 MeV were used to investigate ^{89}Y(d,^{3}He)^{88}Sr reactions. A detailed study of the ^{88}Sr ground state was made using ^{88}Sr(d,^{3}He)^{87}Rb reactions at 35 MeV and ^{88}Sr(^{3}He,d)^{89}Y reactions at 33.4 MeV. Angular distributions are compared with local zero-range DWBA calculations from which the transferred angular momenta and spectroscopic factors are deduced. The analysis indicates that the major proton configurations in the ^{88}Sr ground state are $\sqrt{0.7}(2p_{\frac{1}{2}})^{-2} + \sqrt{0.2}(2p_{\frac{3}{2}})^{-2} + \sqrt{0.1}(1f_{\frac{5}{2}})^{-2}$, in good agreement with recent theoretical calculations. (auth)

29633 ANALOGUE STATES IN ^{73}As VIA THE ^{72}Ge(p,p'e) REACTION. Betigeri, M. G.; Lamba, C. M.; Sood, D. K.; Thampi, N. S. (Bhabha Atomic Research Centre, Bombay). Nucl. Phys.; A185: No. 1, 330-6(1972).

The low-lying states of ^{73}Ge have been excited as isobaric analog states in ^{73}As by the proton bombardment of ^{72}Ge. The decay of these states to the first excited state (0^+) in ^{72}Ge at 690 keV has been observed, and the accompanying conversion electrons have been detected using an orange spectrometer. The excitation function covers isobaric analog states of ^{73}Ge up to an excitation of 1.32 MeV. From the measurement of the total inelastic cross section the partial widths for the states have been calculated. On the basis of these results, the levels at 67 and 673 keV in ^{73}Ge are interpreted to be single-particle neutron states built on the second 0^+ state in ^{72}Ge. (auth)

29634 SYSTEMATICS OF DIRECT PHOTONEUTRON SPECTRA. Mann, David B. Troy, N. Y.; Rensselaer Polytechnic Inst. (1971). 210p. University Microfilms Order No. 72-1203.

Thesis.

The photoneutron spectra of a selected set of naturally monoisotopic and isotopically separated samples Co-59, Y-89, Zr-90, Mo-92, Nb-93, Mo-100, I-127, La-139, Pr-141, Nd-142, Sm-144, Sm-147, Sm-148, Sm-149, Sm-152, Sm-154, Ho-165, Tm-169, and Ta-181, have been examined using 55 MeV bremsstrahlung for the purpose of exploring the mechanism by which non-evaporation neutrons are produced. Angular distributions have been measured for some of the samples. An analysis of the form $W(\Theta) = A_0 + A_1P_1(\cos\Theta) + A_2P_2(\cos\Theta)$ shows that $-A_2/A_0$ values are zero at low energies where the neutron spectra are dominated by statistical emission, gradually increase where direct emission begins, and level off to a constant value for the higher neutron energies. The relative asymmetry, A_1/A_0, was found to be a slowly increasing function of neutron energy. At 18 MeV this value has risen to 0.6 and is still rising. At this energy, the yields at 43° and 90° are approximately equal, and the 128 yields are much smaller. Low energy (0.5 to 2.5 MeV) neutron yields were found to match well with accepted statistical predictions of the several statistical models for which analysis was made. The constant temperature model appears to represent the data at least as well as any of the others. At neutron energies above 13 MeV, direct emission begins to appear and within an MeV or two dominates the yield spectrum. No evidence is found for any preequilibrium emission other than direct emission. The fraction of direct emission was found to be approximately 10 percent for all isotopes studied. The direct emission is found to match well with calculations based on giant resonance absorption through various states obtained mostly from Nilsson diagrams. Alternatively single two hour data runs were analyzed with a set of simplifying assumptions in order to obtain curves which, for the various isotopes studied, near the giant resonance are in excellent agreement with photoneutron giant resonance cross sections found in the literature. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, 90 ≤ A ≤ 149

Refer also to abstracts 27966, 27971, 29169, 29590, 29593, 29604, 29607, 29622, 29624, 29634, 29665, 29705, 29707, 29722, 29757, and 29777.

29635 (CONF-720309-1) SYSTEMATICS OF L = 0 TRANSITIONS OBSERVED IN THE (p,t) REACTION ON NUCLEI NEAR N = 50. Ball, J. B.; Fulmer, C. B.; Larsen, J. S. (Oak Ridge National Lab., Tenn.). [1971]. 8p. Dep. NTIS.

From symposium on two-nucleon transfer and pairing excitations; Argonne, Ill. (20 Mar 1972).

Triton energy spectra were measured for ^{90,92}Zr(p,t) reactions at E_p = 38 MeV and ^{92,94}Mo and ^{96}Ru(p,t) reactions at E_p = 31 MeV. Relative intensities for the population of O^+ states were determined. The systematics for L = 0 transitions in this region are discussed. (J.W.R.)

29636 (COO-3001-1) SECOND ORDER PAIRING PHASE TRANSITION IN THE Sn-ISOTOPES: COMPETITION BETWEEN PAIRING AND SHELL EFFECTS. Broglia, R. A. (State Univ. of New York, Stony Brook. Inst. for Theoretical Physics. Niels Bohr Inst., Copenhagen (Denmark)); Kunz, P. D. (Colorado Univ., Boulder. Dept. of Physics); Nilsson, B. (State Univ. of New York, Stony Brook. Dept. of Physics. Nordisk Institut for Teoretisk Atomfysik, Copenhagen (Denmark)). [1970]. Contract AT-(11-1)-3001. 13p. Dep. NTIS.

The L = 0 transitions observed in the ^{A}Sn(t,p) and ^{A}Sn(p,t) (A even) reactions are analyzed in the framework of the pairing vibrational model. The strong variations of the cross section associated with the $J^\pi = 0^+$ excited states is shown to provide strong evidence for the existence of an incomplete pairing phase transition taking place around masses A = 116 and A = 118. (auth)

29637 (FRNC-TH-170) STUDY OF THE NEUTRON-DEFICIENT NUCLEI NEAR THE 50 PROTON CLOSED SHELL. Rivier, Janine (Universite Scientifique et Medicale de Grenoble (France). Faculte des Sciences). 1971. 147p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The decay of ^{111}Sn, ^{109}In, and ^{107}In was studied in view of establishing decay schemes for the levels of ^{111}In, ^{109}Cd and ^{107}Cd. The γ ray spectra of adjacent isotopes were also studied. Certain results were obtained for the masses 108 and 110. High resolution Ge(Li) detectors were used to study $\gamma-\gamma$ coincidences. Si(Li) detectors were used to study the conversion electrons. The ground state and the first excited levels are interpreted in terms of the shell model. The intrinsic levels of odd Cd isotopes are more difficult to establish because of the strong configurational mixing and their significant collective nature. With ^{111}In, the higher excitation energy levels are interpreted in terms of a coupling between the proton hole and the core of the adjacent tin. The rotation band was not established for this nucleus. (France)

29638 (IJS-P-275) INVESTIGATION OF NUCLEI IN THE REGION WITH Z,N = 50-82, USING THE REACTION (^{16}O,4nγ). Kump, Peter (Institut Jozef Stefan, Ljubljana (Yugoslavia)). Dec 1971. 60p. (In Slovenian). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Ljubljana Univ., Yugoslavia.

The lifetimes of several transitions in the ground-state collective bands of ^{120,122}Xe, ^{126,128}Ba and ^{134}Ce produced by (^{16}O,4nγ) reactions were measured by a recoil-distance Doppler-shift method. The lifetimes obtained were compared with the measured lifetimes of the 2^+ states in the nuclei with $\Lambda \geq 120$ and with measured lifetimes of higher states in the ground-state collective band of Er isotopes. This comparison was done using the empirical relation between the intrinsic quadrupole moments, derived from the measured lifetimes of these states, and the moments of inertia of the states calculated from the variable moment of inertia model (VMI model) of the nucleus. The measured lifetimes of the states higher than 2^+ in Xe, Ba and Ce isotopes give systematically longer lifetimes than expected on the grounds of this comparison. An attempt was made to explain these deviations by the difference in the mechanism of the gamma decay following the (HI,xn) reaction between the nuclei which belong to the transition region (Xe, Ba and Ce), and those belonging to the deformed region (Er). This difference in the mechanism of the gamma decay could be estimated from the decay curves of the highest states in the ground-state collective bands, which indicate besides the lifetimes of the states also the time interval between the reaction (HI,xn) and the population of the ground band. The intensities of the slower feeding components (>700 psec) in Xe, Ba and Ce isotopes exceeds those in Er isotopes for about one order of magnitude. It was suggested that the states along which the gamma deexcitation process following (HI,xn) reaction proceeds are in the nuclei of the transition region different from those in the deformed region. It is concluded that from the measured lifetimes in the ground band of Xe, Ba and Ce the only reliable ones are the lifetimes of the lowest 2^+ states. The measured values are: ^{120}Xe $\tau(2^+)$ = 124.0 ± 15.0 psec, ^{122}Xe $\tau(2^+)$ = 89.0 ± 8.0 psec, ^{126}Ba $\tau(2^+)$ = 173.0 ± 28.0 psec, ^{128}Ba $\tau(2^+)$ = 140.0 ± 30.0 psec, and ^{134}Ce $\tau(2^+)$ = 93.2 ± 12.2 psec. The conclusion is made that the recoil-distance Doppler-shift method using (HI,xn) reactions is not reliable for the determination of the lifetimes of the higher states in the ground-state collective bands of the transition nuclei. More data on the lifetimes of the higher states in the ground-state collective bands in both deformed and transition region of the nuclei are necessary in order to ensure that the conclusions are reliable. (auth)

29639 (OU-LNS-71-9) (N-Z) DEPENDENCE OF DEUTERON STRIPPING CROSS SECTIONS. Isomoto, Y.; Otozai, K.; Sano, M. (Osaka Univ. (Japan). Lab. of Nuclear Stucies). [1969]. 33p. Dep. NTIS (U. S. Sales Only).

Excitation function for the (d,p) reactions decreases as the neutron excess (N−Z) of target nucleus increases. This trend is explained by taking account of the (N−Z) dependence of the potential depth for captured neutrons. Calculations are made on the direct and compound cross sections by using the distorted-wave Born approximation. (auth)

29640 (TID-25920) CYCLOTRON LABORATORY ANNUAL REPORT, MARCH 1, 1970-MARCH 1, 1971. (Michigan Univ., Ann Arbor. Cyclotron Lab.). Mar 1971. Contract AT(11-1)-1112. 93p. Dep. NTIS.

BISMUTH-205—energy levels from lead-204 (He-3,d) reactions, spectroscopic factors for, (E)

BISMUTH-207—energy levels from lead-206 (He-3,d) reactions, spectroscopic factors for, (E)

CYCLOTRONS—development of Michigan Univ., March 1, 1970-March 1, 1971

HOLMIUM-163—energy levels from dysprosium-162 (α,t) reactions, (E)

ION SOURCES—description of gated, at Michigan Univ.

LANTHANUM-139—alpha elastic and inelastic scattering at 45 MeV, DWBA analysis of angular distributions and spectrum from, (E/T)

LEAD-204—alpha inelastic scattering at 45.5 MeV, distorted-wave analysis of angular distributions and spectrum from, (E)

—helium-3 reactions (He-3,d) at 44 MeV, distorted-wave analysis of differential cross sections and spectra from, (E)

LEAD-206—helium-3 reactions (He-3,d) at 44 MeV, distorted-wave analysis of differential cross sections and spectra from, (E)

LEAD-208—alpha reactions (α,t) at 45 MeV, energy spectrum from, (E)
—alpha reactions (α,He-3) at 58 MeV, energy spectra from, (E)
NEUTRON SPECTROMETERS—development of time-of-flight, at Michigan Univ.
NUCLEAR PHYSICS—research at Michigan Univ., March 1, 1970–March 1, 1971
NUCLEI, INTERMEDIATE—alpha reactions (α,xy) at 28.5 MeV with A = 138 to 144, delayed and prompt gamma spectra from, (E)
—energy levels from (α,xy) reactions with A = 138 to 144, lifetimes for, (E)
RUBIDIUM-87—energy levels from strontium-88 (d,He-3) reaction, spectroscopic factors from, (E)
SODIUM-25—energy levels from magnesium-26 (d,He-3) reactions, spectroscopic factors for, E
STRONTIUM-88—deuteron reactions (d,He-3) at 29.0 MeV, distorted-wave analysis of angular distributions and spectrum from, (E) (R.W.R.)

29641 GAMMA–GAMMA DIRECTIONAL CORRELATION EXPERIMENTS IN THE DECAY OF ^{125}Sb. Salzberg, Jose Bernardo. Atlanta; Georgia Inst. of Tech. (1971). 84p. University Microfilms Order No. 72-5049.

Thesis.

Two different sets of gamma–gamma directional correlations were performed on the decay of ^{125}Sb. One of these sets of experiments concerned negative parity levels and consisted in the measurement of the 320 – 177 and 203 – 177 keV cascades. The second set of experiments concerned positive parity levels and consisted in the measurement of gamma–gamma correlations with the 35.5 keV gamma. In particular, the (601 + 606) –35.5, 427 – 35.5 and 636 – 35.5 keV cascades were measured, and information concerning the mixing parameter values for the 427 and 636 keV transitions was obtained. The fixed counter was a 30cc solid state Ge(Li) detector. A movable scintillation detector with a 3 × 3 inch NaI(Tl) crystal was utilized in conjunction with a standard fast-slow coincidence electronic circuit on those experiments involving the negative parity energy levels. In the experiments involving positive parity energy levels it was necessary to substitute a proportional counter for the scintillation counter in order to separate the 35.5 keV radiation from the Te X-rays at approximately 27 keV. Results obtained in these experiments were interpreted in the light of previous results as determined by other investigators, when available in the literature. For the 320 – 177 keV cascade we obtained $A_2 = -0.15(2)$, $A_4 = -0.04(4)$ which gave a mixing ratio $\delta(177) = 0.9$ (+0.9, −0.4) for the 177 keV transition. For the 203 – 177 keV cascade we obtained $A_2 = -0.52(5)$, $A_4 = 0.02(5)$ and δ (203) = 1.0 (+1.1, −0.4) where a spin of $^{11}/_2$ is assigned to the 525 keV level in ^{125}Te. The present results are inconsistent with spin $^9/_2$ for this level. For those cascades involving the 35.5 keV transition the following correlations have been measured: (601 + 606) –35.5 $A_2 = -0.060(20)$, 427 – 35.5 $A_2 = 0.230(30)$, and 636 – 35.5 $A_2 = -0.065(30)$. The first correlation is consistent with L subshell electron conversion measurements that gave $|f(35.5)| \leq 0.03$ ($|\delta| \leq 0.03$). Taking cognizance of other work also, the best mixing parameter values that we may assign are $f(427) \simeq 0.4$ ($\delta \simeq 0.44$) and $f(636) \simeq -0.3$ ($\delta \simeq -0.35$). (Diss. Abstr. Int., B)

29642 COMPARISON OF THE EXPERIMENTAL AND THEORETICAL INTERNAL CONVERSION COEFFICIENTS OF THE γ-RAYS OF ^{117m}Sn. Makaryunas, K. V.; Kalinauskas, R. A. (Inst. of Physics and Mathematics, Vilynus, USSR). Liet. Fiz. Rinkinys; 11: No. 3, 513-16(1971). (In Russian).

An analysis for the experimental and theoretical values of the internal conversion coefficients of the γ-rays of ^{117m}Sn has been performed. A discrepancy between the experimental values and the theoretical ones of Hager and Seltzer for the E_γ = 156.0 keV M4 transition has been found. (auth)

29643 GAMMA RAYS FROM RESONANCE NEUTRON CAPTURE IN ^{143}Nd. Weigmann, H.; Rohr, G.; Heske, M. (EURATOM, Geel, Belgium). Nucl. Phys.; A185: No. 1, 229-35(1972).

Gamma-ray spectra from neutron capture in individual resonances in ^{143}Nd have been measured. Several new levels in ^{144}Nd have been located. Several resonances have been assigned spin 3^- from the observation of a transition to a low-lying 2^+ level. An anticorrelation is observed between the strengths of the transitions from 3^- resonances to one- and two-phonon final states. (auth)

29644 DECAY OF 2.1 h ^{133}Pr. Ludziejewski, J.; Koldewijn, P.; Arnold, H. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys.; A184: No. 2, 473-80(1972).

The decay scheme of ^{133m}Pr was studied using Ge(Li) detectors. Both single and coincidence γ spectra were measured. A decay scheme is proposed incorporating most of the measured γ rays. The log ft values of β-transitions suggest spin and parity 8^- for ^{133m}Pr. The lifetime of the 2217.8-keV 5^- state was found to be less than 0.3 ns. (auth)

29645 0^+–0^+ TRANSITION IN ^{116}Sn. Pleiter, F. (State Univ., Groningen, Netherlands). Nucl. Phys.; A184: No. 2, 443-8(1972).

The conversion electron spectrum of ^{116m}In was measured in a high-resolution magnetic spectrometer. The energy of the first 0^+ level in ^{116}Sn is 1757.0 ± 0.2 keV. The E0 transition from this level to the ground state has an intensity of 2.5 ± 0.2 internal K conversion electrons per 10^5 decays of ^{116m}In. A strength parameter is estimated for this transition. (auth)

29646 STUDY OF THE NEUTRON-RICH ISOTOPES NEAR A = 100 BY MEANS OF THE (t,p) REACTION. Casten, R. F.; Flynn, E. R.; Hansen, Ole; Mulligan, T. J. (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys. 184A: No. 2, 357-76(1972).

The (t,p) reaction was used to study the nuclides ^{102}Mo, ^{106}Ru, and ^{112}Pd, all of which are two neutrons beyond the stable isotopes. A (t,p) spectrum of the ^{102}Ru(t,p)^{104}Ru process was also obtained. The incident triton energy was 15 MeV in all cases and a magnetic spectrograph was used for momentum analysis of the reaction protons with an energy resolution of ≈20 keV FWHM resulting. Differential cross sections were measured for many transitions and spin and parity assignments were made for a number of states. Examinations of the results indicated that only ^{102}Mo shows characteristics of being a transitional nucleus between regions of different nuclear shape whereas the other nuclei studied appear to be in regions where the coupling scheme changes more slowly. The first 2^+ state of ^{102}Mo is markedly lower in excitation energy than in the lighter isotopes and a low-lying 0^+ state is excited with large intensity relative to the ground state. The present results agree with previous results from the Berkeley group on the decay of fission fragments and in a qualitative way support several recent theoretical predictions. (auth)

29647 STUDY OF THE γ RAY SPECTRA EMITTED AFTER RESONANCE NEUTRON CAPTURE BY Sb ISOTOPES. Lottin, A.; Paya, D. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris); 32: No. 11, 849-58(Nov-Dec 1971). (In French).

The analysis of the γ-rays emitted after resonance neutron capture by ^{121}Sb and ^{123}Sb contained in natural antimony is used to assign spins to the resonances, and to establish a scheme for the first excited levels of ^{122}Sb and ^{124}Sb. The partial radiative widths of the spin 2 resonances in ^{121}Sb demonstrate a nonstatistical effect evident from the correlation with the reduced neutron width. (France)

29648 DECAY OF ^{110}Sb, ^{111}Sb, ^{112}Sb, ^{113}Sb AND ^{114}Sb. Singh, Manbir. Los Angeles; Univ. of California (1971). 129p. University Microfilms Order No. 72-5866.

Thesis.

Two previously undiscovered light antimony isotopes, ^{110}Sb and ^{111}Sb, have been produced through the (p,3n) and (p,2n) reactions on ^{113}Sn. Their half lives were found to be 23 ± 1 sec and 75 ± 3 sec respectively. Their decay properties, together with those of ^{112}Sb, ^{113}Sb and ^{114}Sb produced by (p,xn) reactions on enriched ^{112}Sn and ^{114}Sn targets, have been studied, starting with a time delay of approximately 1 sec after the beam exposure. The decay schemes were formulated by performing the following: (a) single counter measurements in which the production and decay constants of gamma transitions were studied as a function of the incident proton energy. Two Ge(Li) detectors (35 cc and 3 cc respectively) were used, and the gamma spectra were stored in successive time intervals on the disc files of an on-line computer; (b) beta-gamma and gamma-gamma coincidence measurements using Ge(Li) detectors for the gamma rays and a stack of Si(Li) detectors for the beta particles; (c) beta spectra end-point measurements for ^{110,111,112}Sb, using a wedge gap beta spectrometer. The energy levels obtained for $^{110-114}$Sn, along with the "ft" values of the beta decays feeding them, are compared to predictions made by models based on quasiparticle and phonon excitations. It is found that the observed overall structure of the tin isotopes is consistent with these predictions, although a weakening of the collective aspects is indicated for ^{110}Sn. (Diss. Abstr. Int., B)

29649 QUADRUPOLE MOMENTS OF THE 2_1^+ STATE OF PROTON-CLOSED-SHELL NUCLEI. Broglia, R. A. (State Univ. of New York, Stony Brook. Univ. of Copenhagen); Liotta, R.; Paar, V. Phys. Lett.; 38B: No. 7, 480-4(3 Apr 1972).

The leading-order contributions (third order in the particle–vibration coupling vertices) to the static quadrupole moment of the lowest $J^\pi = 2^+$ state of Ni, Sn and Pb isotopes were calculated in the framework of a graphical perturbation method. The microscopic structure of the 2^+ phonon is explicitly taken into account and the Pauli principle is respected up to the order of

perturbation in which the quadrupole moments are calculated. (auth)

29650 ISOBARIC ANALOG RESONANCE PROPERTIES IN A UNIFIED MODEL CALCULATION. Vanden Berghe, G. (Rijksuniversiteit, Ghent); Heyde, K.; Waroquier, M. Phys. Lett.; 38B: No. 7, 467-70(3 Apr 1972).

Partial widths for proton inelastic scattering in the reaction $^{140}Ce(p,p')$ to the first excited 2^+ state are calculated in the framework of a unified-model calculation. These values are compared with recent experimental data. Detailed information about the structure of the wavefunctions for levels in ^{141}Ce is given. (auth)

29651 MICROSCOPIC DESCRIPTION OF THE SCATTERING OF HELIONS AND TRITONS WITH REALISTIC INTERACTIONS AND CORE POLARISATION. Park, J. Y. (North Carolina State Univ., Raleigh); Satchler, G. R. Particles Nucl.; 1: No. 4, 233-67(Jan 1971).

An effective interaction for mass-3 nuclei is utilized in a microscopic description of inelastic scattering. Transition densities are constructed from particle–hole mixtures and also from simple two-nucleon shell-model configurations. In the latter case, core polarization effects are shown to be very important. Results for the former case are compatible with measured cross sections. It is suggested that the effective interaction may also have an important imaginary component, and a way of investigating this through its interference with Coulomb excitation is suggested. (14 figures, 2 tables, 50 references) (auth)

29652 STATES IN ^{93}Mo TO 5 MeV BY $^{92}Mo(d,p\gamma)^{93}Mo$ COINCIDENCE MEASUREMENTS. Matthews, Dennis, L.; Hopkins, F. F.; Richard, Patrick; Phillips, G. W.; Moore, C. Fred (Univ. of Texas, Austin). Phys. Rev., C; 5: No. 4, 1390-7(Apr 1972).

Measurements of the decay from excited states in ^{93}Mo following sub-Coulomb stripping were made using the reaction $^{92}Mo(d,p\gamma)^{93}Mo$ at an incident deuteron energy of 6.0 MeV. Both particle and γ-ray singles measurements were made using Si(Li) and Ge(Li) detectors. Proton–γ coincidence spectra produced by 43 gates on proton groups associated with ^{93}Mo were accumulated by means of a two-parameter computer sorting program, and yielded 24 levels with energies up to 5 MeV in excitation. A total in excess of 50 γ rays was assigned to the deexcitation of levels in ^{93}Mo. Branching ratios at $\theta_L = 90°$ are given for the transitions from the excited states along with a decay scheme observed following the (d,p) reaction. (6 figures, 2 tables) (auth)

29653 ENERGY LEVELS IN ^{97}Mo FROM COULOMB EXCITATION MEASUREMENTS. Barrette, J. (Univ. of Montreal); Barrette, M.; Haroutunian, R.; (and others). Phys. Rev., C; 5: No. 4, 1376-9(Apr 1972).

The low-lying states of ^{97}Mo were investigated via Coulomb excitation by using α and ^{16}O projectiles. Eleven states up to 1515 keV, including three unreported levels at 481, 721, and 1093 keV, were excited; and their $B(E2)_{ex.}$ values determined. The revealed complexity of the level structure of ^{97}Mo provides a strong argument against good closure of the $d_{\frac{5}{2}}$ shell at N = 56 in molybdenum. (3 figures, 1 table) (auth)

29654 AVERAGE TOTAL NEUTRON CROSS SECTIONS OF HEAVY ELEMENTS AT 2.7 keV. Dilg, W.; Vonach, H. K. (Technical Univ., Munich). pp 327-34 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

Average total cross sections of 31 heavy elements (A > 100) at 2.7 keV mean neutron energy have been measured at the Munich Research Reactor FRM. The data were used to study the s-wave strength function in the mass range of the 4s giant resonance. (auth)

29655 SOME EVIDENCE FOR NEUTRON PICK-UP FROM THE INTERIOR CORE THROUGH THE (p,d) REACTION. Ishimatsu, T. (Tohoku Univ., Sendai); Hayashibe, S.; Kawamura, N.; (and others). Nucl. Phys.; A185: No. 1, 273-83(1972).

The (p,d) reactions on $^{94,98,100}Mo$ were studied with 52 MeV protons. Deuteron spectra were measured up to 12 MeV of excitation in the residual nuclei. The angular distributions for the three reactions integrated over the final levels in a range of excitation from 2 to 6 MeV are in good agreement with each other, though the relevant parts of the deuteron spectra apparently show isotope-dependent structures. From a comparison of the results obtained in this study with those from the (p,d) reactions on neutron closed-shell nuclei ^{90}Zr and ^{92}Mo, it is indicated that the (p,d) transitions to the levels in this particular range of excitation in $^{93,97,99}Mo$ are mainly due to neutron pick-up from the N = 29–50 major shell and that the transition strengths integrated over these transitions are in fair agreement with the sum-rule limit. A comparison is also made between the results obtained in this study and those from the (p,d) reactions on $^{117,118}Sn$, from which it is suggested that the broad peaks found in the deuteron spectra from the latter two reactions at excitation energies between 7–12 MeV in ^{118}Sn and 5–10 MeV in ^{117}Sn are mainly due to neutron pick-up from the N = 29–50 shell. Again, the transition strengths for the broad peaks are estimated to be in fair agreement with the sum-rule limit. (auth)

29656 LEVELS OF ^{128}Te POPULATED IN 8.9 h β^- DECAY OF ^{128}Sb. Kerek, A. (Research Inst. for Physics, Stockholm). Nucl. Phys.; A185: No. 2, 497-508(1972).

The γ-ray and conversion electron spectra associated with the decay of 8.9 h ^{128}Sb have been measured with Ge(Li) and Si(Li) detectors. The antimony samples were produced using the on-line isotope separator OSIRIS to isolate the fission products from ^{235}U. On the basis of the measured singles and γ-γ coincidence spectra, a new level scheme has been constructed. The observed positive-parity states are 743.3 keV 2^+, 1497.3 keV 4^+, 1811.4 keV 6^+ and 3151.5 keV $(7,8)^+$. The nature of the 1811.4 keV 6^+ state is discussed. The 2133.5 keV 5^- and 2337.9 keV 7^- negative-parity states are interpreted to have $(h_{\frac{11}{2}},s_{\frac{1}{2}})$ and $(h_{\frac{11}{2}},d_{\frac{3}{2}})$ two-neutron configuration. (auth)

29657 SPECTRUM OF K–LL-AUGER ELECTRONS OF TELLURIUM AND XENON. Babenkov, M. I.; Bobykin, B. V.; Petukhov, V. K. (Inst. of Nuclear Physics, Alma-Ata, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 8, 1586-92(Aug 1971). (In Russian).

The spectrum of the K– LL electrons of Te and Xe was studied with a magnetic β-spectrometer with double focussing with r_0 = 243 mm. The spectral data were processed by the method of least squares on an electronic computer. The chi-squared criterion was applied to obtain the degree of plausibility of the curves which approximated the contours of the K– LL spectra. Eight lines were recognized in the Te spectrum (Z = 52), and 11 lines developed in the Xe spectrum (Z = 54); the relative intensities of these lines were measured. (tr-auth)

29658 EXCITATION FUNCTIONS AND ISOMER RATIOS FOR NEUTRON-INDUCED REACTIONS ON ^{92}Mo AND ^{90}Zr. Kanda, Y. (Kyushu Univ., Fukuoka). Nucl. Phys.; A185: No. 1, 177-95(1972).

Absolute cross sections of the reactions $^{92}Mo(n,2n)^{91m,91g}Mo$, $^{92}Mo(n,p)^{92}Nb$ and $^{92}Mo(n,\alpha)^{89m,89g}Zr$, relative cross sections of the reaction $^{90}Zr(n,2n)^{89m}Zr$ and isomer ratios of the $^{90}Zr(n,2n)$ reaction have been measured in the neutron energy range 13 to 15 MeV. The results for the (n,2n) reactions are in good agreement with those of the previous studies. The present results for the (n,p) and (n,α) reactions are in disagreement with the previous works. The experimental data are analyzed by the statistical model to determine the level-density parameter a, the moment of inertia I and the strength of the γ-ray transition S_1 in order to simultaneously reproduce the experimental data on the excitation function and the isomer ratio in the (n,2n) reaction. The γ-ray competition, the yrast level and the experimental information on the excited levels of the residual nucleus in the (n,2n) reaction are taken into account. The obtained values of a, I, and S_1 are consistent with those deduced from other types of nuclear data. (auth)

29659 CROSS-SECTION AT 14.0 MeV OF THE $^{93}Nb(n,2n)^{92}Nb$ REACTION, AND ITS RELEVANCE TO FUSION REACTOR TECHNOLOGY. Blow, S. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy; 26: No. 1, 9-16(Jan 1972).

Activation measurements on the $^{93}Nb(n,2n)^{92}Nb$ reaction give a cross-section value of ~450 mb at 14.0 MeV. Theoretical calculations yield a value in the range 1100 to 1200 mb. It is suggested that the latter is the correct value. The argument is based on the supposition that the ground state of ^{92}Nb has a very long half-life, and that it is only the activity of the first excited state (10.2 day half-life) that is measured. A calculation of level excitation using the Troubetzkoy formalism shows that the proportion of decays landing in the first excited state to those going to ground is 1 to 1.5. Thus the activation cross-section of 450 mb should be multiplied by 2.5 to give a true value of ~1100 mb at 14.0 MeV. If the (n,2n) cross-section is to be increased by 650 mb then the inelastic cross-section must be decreased from 1500 mb to 850 mb to keep the balance in the non-elastic value. Such alterations have important consequences in the field of fusion reactor blanket technology, niobium being a favored structural material. Calculations on neutron spectra, tritium breeding, heating rates, γ-ray production, radioactivity and transmutation will all be affected. (auth)

29660 TOTAL CROSS SECTION OF RUTHENIUM ISOTOPES 99, 100, 101, 102, AND 104 IN THE RESONANCE REGION. Priesmeyer, H. G.; Jung, H. H. (Univ., Kiel). Atomkernenergie; 19: No. 2, 111-16(Apr 1972). (In German).

The total neutron cross sections of the stable ruthenium isotopes 99, 100, 101, 102, and 104 have been measured with the Kiel fast-chopper time-of-flight spectrometer between 1 and 1500 eV. Different sample thicknesses of natural ruthenium and separated ruthenium isotopes have been used to determine parameters by area analysis for 51 resonances. Most of them could be assigned isotopically. Values for Γ_γ are given for ^{99}Ru and ^{101}Ru resonances up to 120 eV. Average level spacings per spin state, $\bar{D}$, and strength functions, S, are derived from the resonance parameters for ^{99}Ru, ^{101}Ru, ^{102}Ru, and ^{104}Ru. (auth)

29661 TIME-DIFFERENTIAL QUADRUPOLE INTERACTIONS FOLLOWING RECOIL IMPLANTATION. McDonald, J. M.; Lesser, P. M. S.; Fossan, D. B. (State Univ. of New York, Stony Brook). Phys. Rev. Lett.; 28: No. 16, 1057-60(17 Apr 1972).

The quadrupole interaction of the 247-keV state of ^{111}Cd recoil implanted into polycrystalline Cd metal has been measured by the time-differential perturbed angular-correlation technique, following Coulomb excitation. The resulting interaction frequencies at three temperatures are in agreement with the recently measured lattice quadrupole interaction in Cd. This observation of a usable electric field gradient for recoil nuclei suggests the possibility of measuring excited-state quadrupole moments by such time-differential studies following nuclear-reaction implantation into metals. (auth)

29662 ELASTIC AND INELASTIC SCATTERING OF α PARTICLES AND PROTONS FROM ^{144}Sm AND ^{138}Ba. Barker, James Howard. College Station, Tex.; Texas A and M Univ. (1971). 99p. University Microfilms Order No. 72-5637.

Thesis.

Differential cross sections for the elastic scattering and inelastic scattering to the low-lying states in ^{144}Sm and ^{138}Ba have been measured using 50 MeV α particles and 30 MeV protons on ^{144}Sm and 50 MeV α particles on ^{138}Ba. The angular distributions are analyzed in the distorted wave Born approximation, employing collective model form factors. Spin and parity assignments of 2^+, 3^-, and 4^+ are verified for states at 1.66, 1.81 and 2.19 MeV in ^{144}Sm. A 2^+ assignment is made for a state at 2.45 MeV. In ^{138}Ba spin and parity assignments of 2^+, 4^+ and 3^- are verified for states at 1.436, 1.898 and 2.880 MeV. Assignments of 2^+ and 4^+ are made for states at 2.19 and 2.27 MeV. Tentative assignments of 2^+ and 4^+ are made for members of unresolved doublets at 3.34 and 3.50 MeV, respectively. $\beta_1 R$ values are given for all observed states. Reasonable agreement is obtained between these results and previous experimental data and recent theoretical calculations. (Diss. Abstr. Int., B)

29663 VECTOR ANALYSIS OF TIME-DEPENDENT GAMMA-RAY SPECTRA. Filippone, W. L.; Munno, F. J. (Univ. of Maryland, College Park). Nucl. Technol.; 14: No. 2, 200-2(May 1972).

A method for the vector analysis of experimental gamma spectra is described which makes use of both the energy characteristics and time behavior of the pulse height spectrum. A technique for effectively combining the method with the least squares method is discussed. The results of a test of the vector analysis method are presented. (J.W.R.)

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Refer also to abstracts 29513, 29573, 29634, 29654, 29690, 29714, 29729, 29734, 29738, and 29818.

29664 (AERE-R-6965) EXCITATION FUNCTIONS FOR THE FORMATION OF VARIOUS GADOLINIUM AND LUTETIUM ISOTOPES BY (d,xn) REACTIONS. Nichols, A. L.; Bullock, R. J.; Glentworth, P.; Large, N. R. (Atomic Energy Research Establishment, Harwell (England)). Jan 1972. 11p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

Excitation functions for the production of gadolinium-153 by the (d,2n) reaction on europium-153, and for the production of neutron deficient lutetium isotopes by (d,xn) reactions on natural ytterbium, were measured. Irradiations were carried out on the Harwell Variable Energy Cyclotron, and a deuteron energy range of 13 to 30 MeV was studied. The nuclides produced were determined by γ-spectrometry with a Ge(Li) detector. (auth) (UK)

29665 (BLG-460, pp 3,19-26) NUCLEAR PHYSICS. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 1970. 10p.

In Annual scientific report, 1970.

BROMINE-87—half-life and delayed neutron emission probability of, (E)
EUROPIUM—neutron total cross section at 0.253 eV, (E)
EUROPIUM-151—neutron capture at 0.253 eV, cross sections and isomer ratio for, (E)
IODINE-137—half-life and delayed neutron emission probability of, (E)
TANTALUM-183—energy-level scheme from tantalum-182 neutron capture, (E)
URANIUM-235—half-life of isomeric, (E) (J.W.R.)

29666 (COO-3463-2) EXCITATION FUNCTION AND ISOMER RATIOS FOR HEAVY ION INDUCED REACTIONS. Sperber, Daniel (Rensselaer Polytechnic Inst., Troy, N. Y.). [1971]. Contract AT(11-1)-3463. 14p. Dep. NTIS.

A method for the calculation of excitation functions and isomer ratios in heavy ion induced reactions is developed. The method is applied to the calculation excitation function and isomer ratio for the reaction Dy(^{40}Ar,xn)Po. Calculated values are compared with experiment. (auth)

29667 (LYCEN-7162) INVESTIGATION OF ^{165}Er LEVELS EXCITED IN DECAY OF ^{165}Tm. Marguier, G.; Chery, R. (Lyon Univ. (France). Institut de Physique Nucleaire). Sep 1971. 36p. (In French). Dep. NTIS (U. S. Sales Only).

Investigation of the decay of ^{165}Tm from observations of $\gamma-\gamma$ and $e-\gamma$ coincidences with Ge(Li) detectors revealed new excited levels of ^{165}Er at 62.7 keV, 97.9 keV, 519.1 keV, 534.9 keV, 1416.8 keV, and 1521.5 keV. The negative parity states of ^{165}Er are found to agree well with the theoretical states calculated in the framework of the quasi-particle model in which quasi-particle-phonon interactions are taken into account. (France)

29668 (ORO-4282-1) DECAY OF ^{157}Sm. Morcos, N. A.; Adams, D. E.; James, W. D.; Kuroda, P. K. (Arkansas Univ., Fayetteville, Dept. of Chemistry). [1972]. Contract AT(40-1)-4282. 11p. Dep. NTIS.

Irradiation of enriched ^{160}Gd with fast neutrons was found to produce a new radioactivity which was assigned to the (n,α) product ^{157}Sm. The following radiation characteristics were observed to belong to ^{157}Sm: half-life 83 ± 2 sec, γ-ray energy 121.5 ± 0.5 keV, and maximum β^--ray energy 2.83 ± 0.05 MeV. (auth)

29669 MOMENT OF INERTIA OF ^{158}Dy FROM EXCITATION OF THE GROUND-STATE BAND TO SPIN 22. Thieberger, P.; Sunyar, A. W.; Rogers, P. C.; (and others) (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 28: No. 15, 972-4(10 Apr 1972).

The behavior of the moment of inertia for high-spin states in ^{158}Dy has been studied by populating the ground-state band up to spin 22 through the reaction ^{150}Nd(^{13}C,5N)^{158}Dy at bombarding energies of up to 72 MeV. The rate of increase of the moment of inertia I with rotational frequency rises abruptly in the region from spin 14 to 18. In the region of spin 22, I tends toward a more constant value. (auth)

29670 STUDY OF ^{168}Er BY ISOBARIC ANALOG RESONANCE TECHNIQUE. McShan, Daniel Lee. Lafayette, Ind.; Purdue Univ. (1971). 158p. University Microfilms Order No. 72-7998.

Thesis.

This experiment involved nuclear structure studies of ^{168}Er through the formation and decay of the isobaric analogs of ^{169}Er. The analog resonances were seen as highly excited compound states formed during proton scattering. A proton beam, provided by the Purdue Van de Graaff accelerator, was utilized to obtain 10 to 12 MeV excitation functions. These excitation functions were taken at angles 89.9, 125.2, 140.8, and 170° and also at 74.6, 109.9, 125.5, and 154.7°. Detector resolution for these excitation functions was as good as 10 keV for 10 MeV protons, using cooled lithium-drifted silicon detectors. The ground state resonances were observed at an energy of 10.53 MeV, yielding a coulomb displacement energy for ^{169}Er of 16.53 ± .02. Moreover a positive parity state was seen in the elastic excitation functions and was assigned to the band head of the $\frac{1}{2}$ + [651] particle state. Inelastic studies in this experiment directly revealed considerable mixing in the various states of the involved nuclei. These results agreed in general with supposed structure implied in other experiments. The main results of this experiment showed that the analog resonance technique can be used successfully for the extraction of nuclear information concerning deformed nuclei. (Diss. Abstr. Int., B)

29671 DECAY OF ^{161}Er TO LEVELS IN ^{161}Ho. Wood, J. L.; Brenner, D. S. (Clark Univ., Worcester, Mass.). Nucl. Phys.; A185: No. 1, 58-80(1972).

The γ-ray spectrum of the decay chain ^{161}Er → ^{161}Ho → ^{161}Dy has been studied with Ge(Li) detectors. Results of γ-ray singles and coincidence experiments are reported and decay scheme for ^{161}Er → ^{161}Ho is proposed. Asymptotic quantum-number assignments are made for several new energy levels in ^{161}Ho and the

results are compared to predictions of the unified model. No evidence was found for the population of three-quasiparticle states in ^{161}Ho. De-excitation of the $\frac{3}{2}^-\{\frac{7}{2}^-[523], 2^+\}$ γ-vibrational state and Coriolis coupling in the $\frac{1}{2}^+[411]$ rotational band are discussed. (auth)

29672 EVIDENCE FOR VIOLATION OF THE GALLAGHER–MOSZKOWSKI RULES IN ^{154}Pm. Tannila, O.; Kantele, J. (Univ. of Jyvaeskylae, Finland). Z. Phys.; 251: No. 2, 87-92 (1972).

The existence of two radioactive species of ^{154}Pm (1.8 min ground state and 2.65 min isomer) is established. The Nilsson model configurations assigned to these states give evidence against the validity of the Gallagher–Moszkowski coupling rules in ^{154}Pm. (auth)

29673 LIFETIMES OF GROUND-BAND STATES IN ^{154}Sm. Diamond, R. M.; Symons, G. D.; Quebert, J. L.; (and others) (Univ. of California, Berkeley). Nucl. Phys.; A184: No. 2, 481-96(1972).

Lifetimes of the $8 \rightarrow 6$, $6 \rightarrow 4$ and $4 \rightarrow 2$ ground-band transitions in ^{154}Sm were measured by a recoil-distance Doppler-shift technique following Coulomb excitation by back-scattered ^{40}Ar projectiles. Within experimental error, the measured B(E2) values are those of a rigid rotor. These results and those of a previous experiment on ^{152}Sm are compared with current models. (auth)

29674 TRANSITION PROBABILITY E0 AND E2 OF ^{178}Hf. Gizon, J. (Institut des Sciences Nucleaires, Grenoble, France); Ohlsson, H.; Valentin, J.; Lombard, R. J. Nucl. Phys.; A185: No. 1, 321-9(1972). (In French).

The electric-monopole transitions of ^{178}Hf have been studied from the decay of 22 d ^{178}W and 9.3 min ^{178}Ta by means of a 50 cm radius iron-free double-focussing spectrometer. Percentages of E0 electrons in the E0 + M1 + E2 transitions of 1183 and 1403 keV have been obtained. The B(E0)/B(E2) transition probability ratios and deformation parameter β are discussed. (auth)

29675 DETAILED STUDY OF LOW-LYING LEVELS OF ^{184}W BY MEANS OF THE (d,p) REACTION. Isoya, Akira; Maki, Takashi; Nakashima, Takao; (and others) (Kyushu Univ., Fukuoka). J. Phys. Soc. Jap.; 32: No. 4, 886-98(Apr 1972).

Targets of separated isotopes ^{182}W and ^{183}W were bombarded with a 15 MeV deuteron beam, and outgoing protons were analyzed with a broad range magnetic spectrograph and nuclear emulsion plates. Empirical single-particle cross sections were determined from the observed cross sections and angular distributions of the reactions leading to low-lying levels of ^{183}W. Observed cross sections and angular distributions for the levels of ^{184}W were compared with the cross sections which were obtained by using the above empirical single-particle cross sections and the spectroscopic factors calculated from the pairing theory. For the members of the ground state rotational band and the γ-vibrational band in ^{184}W excellent agreements were obtained. Reasonably good agreements were found for six higher levels below 1800 keV, if they were interpreted as the rotational members of possible two-quasiparticle states. For the first two levels of the lowest excited $K = 0^+$ band cross sections were determined. (auth)

29676 MIXING PARAMETER FOR THE MIXING OF GAMMA-VIBRATIONAL AND GROUND-STATE BANDS IN ^{160}Dy. McAdams, R. E.; Otteson, O. H. (Utah State Univ., Logan). Z. Phys.; 250: No. 5, 359-69(1972).

The energies and relative intensities of the gamma rays depopulating the first gamma-vibrational level in ^{160}Dy were determined using Ge(Li) detectors. Special care was given to the determination of the intensities of the 682-, 765-, 872-, 962-, and 1069-keV gamma rays. From the measured intensities the reduced E2 transition probability ratios were calculated for the transitions between the gamma band and ground-state band. The deduced $Z_2 \times 10^3$ values are 51.9 ± 3.5, 38.7 ± 3.6, 31.6 ± 5.3, 34.5 ± 5.9, and 42.0 ± 7.2, with an average value of 39.7 ± 3.5. The internal conversion coefficients of the 682- and 765-keV transitions are also shown to be consistent with the theoretical E2 values. (3 figures, 2 tables) (auth)

29677 INVESTIGATION OF THE CAPTURE GAMMA-RAY SPECTRA FOR INDIVIDUAL RESONANCES IN THE ^{169}Tm(n,γ) REACTION. Thomas, B. W. (Atomic Energy Research Establishment, Harwell, Eng.). pp 251-6 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23, Aug 1971).

High-resolution γ-ray pulse height and neutron time-of-flight information were obtained for the ^{169}Tm(n,γ) reaction for neutron energies up to 160 eV. Spin assignments for several resonances were made. Gamma ray intensities were examined for correlations with reduced neutron widths. (J.W.R.)

29678 J-DEPENDENCE OF LEVEL DENSITY IN ^{180}Hf AND ^{178}Hf FROM STATISTICAL PROPERTIES OF SERIES OF RESONANCES WITH ASSIGNED SPIN. Coceva, C.; Corvi, F.; Giacobbe, P.; Stefanon, M. (CBNM-EURATOM, Geel, Belgium. CNEN, Bologna). pp 447-54 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The spin-cutoff parameter was evaluated for the level densities of states in ^{180}Hf and ^{178}Hf excited by low-energy s-wave neutron capture in ^{179}Hf and ^{177}Hf. Spins were assigned to 85 resonances in ^{179}Hf below 430 eV. Spins were assigned to 99 resonances in ^{177}Hf below 300 eV. Very narrow confidence limits were assigned to the spin cutoff parameter in ^{180}Hf. The results for ^{177}Hf suggest that in some cases the spin-cutoff value determined on such small energy intervals may be unreliable. (J.W.R.)

29679 YIELDS OF K ISOMER, BETA, AND GROUP BANDS IN Yb(α,xnγ)^{174}Hf REACTIONS. Ejiri, H. (Osaka Univ. Univ. of Copenhagen); Hagemann, G. B.; Hammer, T. pp 483-7 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The role of the K-quantum number in the deexcitation of high spin compound nuclei in the deformed region was investigated by Yb(α,xnγ) reactions. The γ spectra following the ^{171}Yb(α,n) and ^{172}Yb(α,2n) reactions at E_α = 20 to 28 MeV were measured with a Ge(Li) detector. The results show that the γ decay of ^{174}Hf states is affected by the K selection rules. (J.W.R.)

29680 K-SHELL AUTO-IONIZATION IN THE BETA DECAYS OF ^{151}Sm, ^{169}Er, AND ^{210}Bi. Campbell, J. L.; McNelles, L. A.; Law, J. (Univ. of Guelph, Ont.). Can. J. Phys.; 49: No. 24, 3142-9(15 Dec 1971).

The K-shell auto-ionization probability was measured by Ge(Li) spectroscopy for three β^- decays of low, medium, and high energy The values obtained, $(0.041 \pm 0.006) \times 10^{-4}$ for ^{151}Sm, $(1.0 \pm 0.2) \times 10^{-4}$ for ^{169}Er, and $(1.23 \pm 0.1) \times 10^{-4}$ for ^{210}Bi, are discussed in terms of existing theories, and modifications to the latter are suggested. (auth)

29681 INVESTIGATION OF THE DECAY ^{182}Re → ^{182}W. Galan, P. (Inst. of Physics, Bratislava); Vejs, M. Czech. J. Phys.; 22: No. 1, 18-37(1972).

The single gamma-ray spectrum and gamma-gamma coincidence spectra have been studied in the decay of 64-hour isomer of ^{182}Re with the aid of large coaxial Ge(Li)-detectors. A total of 14 new gamma-ray transitions have been observed and three new levels introduced. The experimental values of internal conversion coefficients for majority of transitions were determined and conclusions about their multipolarities were drawn. The character of the decay of the investigated ^{182}Re isomer (64-hour) indicates that it is most probably the p 402 ↑ + n 624 ↑ 7^+-state. (auth)

29682 DECAY OF ^{157}Ho TO ^{157}Dy. Torres, J. P. (Centre de Spectrometrie Nucleaire et de Spectrometrie de Masse, Orsay, France); Paris, P.; Kilcher, P. Nucl. Phys.; A185: No. 2, 574-92(1972). (In French).

The decay of ^{157}Ho to ^{157}Dy ($T_{\frac{1}{2}}$ = 12.6 min) was investigated by means of Ge(Li) and Si(Li) detectors. With the help of a multidimensional coincidence device a scheme with several levels explained in terms of the single-particle Nilsson model is proposed. (auth)

29683 INVESTIGATIONS OF THE LEVEL STRUCTURE AND OF THE ROTATION–VIBRATION INTERACTION IN ^{156}Gd AND ^{158}Gd. Kluk, Anthony Floyd. Nashville; Vanderbilt Univ. (1971). 196p. University Microfilms Order No. 72-3221. Thesis.

Accurate energies and intensities of γ rays in the decay of 15-d ^{158}Eu and 46-min ^{158}Eu were measured through the use of large-volume, high resolution Ge(Li) detectors in both the singles and γ-γ coincidence modes. Special emphasis was given to measuring the intensities of the γ rays that depopulate the β- and γ-vibrational bands of both nuclei. The 0^+ and 2^+ members of the β-band and the 2^+ members of the γ-band in ^{156}Gd were observed. In ^{158}Gd, the 2^+ and 3^+ members of the γ-band were reported as well as weak evidence for the γ-rays that depopulate the 0^+ and 2^+ members of the β-band. The γ branching ratios from the levels of the β- and γ-bands are interpreted in terms of the Bohr–Mottelson collective model with a first and second order perturbation treatment of the mixing between the β- and γ-bands and the ground state rotational band. For both nuclei, a first order perturbational treatment did

not account for the branching ratios between the γ-vibrational and ground-state rotational bands. Mixing between the β- and γ-vibrational bands is considered from two approaches, but it was concluded that neither accounts satisfactorily for the branching ratios of both the β- and γ-vibrational bands of ^{156}Gd. Coincidence relationships were used extensively to establish new level schemes, which give a more detailed picture of the decay properties of both ^{156}Eu and ^{158}Eu. On the basis of half-life measurements, 95 transitions were observed in the decay of ^{156}Eu, 84 of which were assigned to a level scheme of 26 excited states in ^{156}Gd. From ^{156}Eu decay, 89 of 140 observed transitions and 29 excited levels were placed in the level scheme of ^{158}Gd. Possible spins and parities were determined for the excited states and a detailed discussion of the features of each assigned level is given for both nuclei. (Diss. Abstr. Int., B)

29684 123 keV K, L, AND M SHELL PARTICLE PARAMETERS IN ^{154}Gd. Blanchard, W. J.; Zganjar, E. F. (Louisiana State Univ., Baton Rouge). Nucl. Phys.; A185: No. 1, 196-208(1972).

The K, L, and M shell particle parameters of the 123-keV transition in ^{154}Gd were carefully measured under five controlled experimental conditions in order to deduce the possible effects which could alter the γ-e and γ-γ directional correlations. The results show that the correlations are sensitive to the preparation, chemical composition and physical environment of the source; and that when careful experimental procedures are employed, the K, L, and M shell parameters are found to be normal. An explanation is offered for the contradictory results obtained by other investigators using Eu oxide and Eu chloride sources. (auth)

29685 ^{186}Re: NUCLEAR STRUCTURE AND AN ISOMER OF HALF-LIFE 2×10^5y. Seegmiller, D. W. (Air Force Academy, Colorado Springs, Colo.); Lindner, M.; Meyer, R. A. Nucl. Phys.; A185: No. 1, 94-112(1972).

A long-lived isomer of ^{186}Re was isolated from neutron-irradiated rhenium metal. The existence of this isomer is attributed to a 50-keV E5 transition from a level assigned the configuration 8^+ $\{5/2^+[402\uparrow]_p; 11/2^+[615]_n\}$. A half-life of 2×10^5 y was determined by a combination of mass-spectrometric analysis and γ-ray spectrometry with Ge(Li) detectors. The decay properties are compared with earlier studies of the low-level structure of ^{186}Re. This isomer is formed in approximately 0.3% of the thermal-neutron captures in ^{185}Re. (auth)

Nuclear Properties and Reactions, 190 ≤ A ≤ 219

Refer also to abstracts 29520, 29552, 29583, 29587, 29590, 29604, 29640, 29649, 29651, 29654, 29680, and 29839.

29686 (LBL-246) EXPERIMENTAL INVESTIGATION OF THE ELECTRON CAPTURE DECAY OF ^{210}At AND ^{209}At: THE LEVEL SCHEMES OF ^{210}Po AND ^{209}Po. Jardine, Leslie James (California Univ., Berkeley. Lawrence Berkeley Lab.). Dec 1971. Contract W-7405-eng-48. 363p. Dep. NTIS.
Thesis.

The nuclear levels of ^{210}Po and ^{209}Po populated by the electron-capture decay of ^{210}At and ^{209}At have been studied. Experimental level schemes have been constructed by using data obtained from gamma-ray singles, internal conversion electron, and gamma-gamma coincidence measurements with high resolution Ge(Li) and Si(Li) spectrometers. For the case of ^{210}Po, present data have been used to define twenty-three levels. The multipolarity of thirty-six transitions in ^{210}Po have been determined and combined with data from recent reaction studies to assign spins and parities to the levels. All levels arising from the two-proton configuration $(h_{9/2})^2$ and from the multiplets due to the configurations $(h_{9/2}f_{7/2})$ and $(h_{9/2}i_{13/2})$, except for the lowest spin members, have been identified. The level structure is compared with two-proton shell model calculations and experimental transition probabilities for gamma decay of the $(h_{9/2}f_{7/2})$ and $(h_{9/2})^2$ proton multiplets are compared with predictions using several sets of shell model wavefunctions. Evidence is presented which locates the 3^- collective level in ^{210}Po at 2400 keV above the ground state. The electron-capture transition rates to odd parity levels above 2.9 MeV are discussed in terms of neutron-neutron and proton-proton particle-hole excitations of the ^{208}Pb core. A weak-coupling calculation using experimental data of neighboring isotopes in the lead region is made for the energies of the 3^- and 5^- core states of ^{210}Po. For the case of ^{209}Po, twenty levels have been defined by the present data. Multipolarities of thirty-one transitions in ^{209}Po have been determined and used to assign spins and parities to the levels. Five states arising from the odd neutron in ^{209}Po have been assigned by a comparison of the experimental level spectrum and the decay characteristics of levels with a shell model calculation and the levels in ^{207}Pb. A weak coupling calculation using experimental data from isotopes in the lead region to approximate residual interactions was found to explain the level structure of ^{209}Po below 2 MeV. (auth)

29687 (LYCEN-7146) MEASUREMENTS OF THE TRANSITION PROBABILITIES IN ^{196}Hg AND ^{194}Pt. Troncy, Andre (Lyon Univ. (France). Institut de Physique Nucleaire). Jul 1971. 15p. (In French). Dep. NTIS (U. S. Sales Only).
Thesis. Submitted to Lyon Univ. (France).

A unit for measuring lifetimes by delayed coincidences was developed. Measurements by displacement of the center of gravity are very sensitive to errors introduced by differences in the selection energy, which affect the triggering time. A system that compensates these errors and improves the intrinsic resolution was developed for this unit. The performance is presented. The lifetimes of the 5^- and $(6^-, 7^-)$ states of ^{196}Hg, and the 2^+ and $2^{+\prime}$ states of ^{194}Pt were measured with this equipment. The transition probabilities were derived from these measurements. The values obtained are compared with experimental and theoretical values obtained elsewhere. It is confirmed that the 47.8-keV transition of ^{196}Hg is highly accelerated and that the 58.8-keV transition is very delayed in relation to the single particle model. Lifetime measurements of the two first states of ^{194}Pt confirm the value obtained for the first level; the half-life of the second level was determined. (France)

29688 DECAY OF ^{195m}Pb AND ^{197m}Pb. Hopke, P. K.; Huebel, H.; Naumann, R. A.; Spejewski, E. H.; Strigachev, A. T. (Princeton Univ., N. J.). Nucl. Phys.; A184: No. 2, 497-506(1972).

Ge(Li) γ spectra, Si(Li) electron spectra, and Ge(Li)-Ge(Li) coincidence spectra were obtained from ^{195m}Pb and ^{197m}Pb sources. These data were used to construct partial energy level schemes for the ^{195}Tl and ^{197}Tl daughters. The data are consistent with a spin and parity of $9/2^-$ for the isomeric states in both thallium isotopes. (auth)

29689 DO ELECTRON SCATTERING AND MUONIC X-RAY DATA REALLY REQUIRE A CENTRAL DEPRESSION IN THE CHARGE DISTRIBUTION OF ^{208}Pb? Faessler, Amand; Galonska, J. E.; Goeke, K. (Kernforschungsanlage, Juelich, Ger.). Z. Phys.; 250: No. 5, 436-45(1972).

The charge distribution of ^{208}Pb calculated in the Hartree-Fock (HF) approach by using the density-dependent nucleon-nucleon interaction of Ehlers and Moszkowski, is tested by simultaneous comparison with experimental data from 502-MeV elastic electron scattering and muonic atoms. In both cases the agreement is very good and nearly as good as the best fits with a phenomenological charge distribution of the Fermi type, if the effect of the polarization of the nucleus due to the presence of the muon is properly taken into account. In contradiction to the Fermi fits, the HF distribution shows a hump at the center of the nucleus. (2 figures, 1 table) (auth)

29690 INFLUENCE OF SHELLS AND PAIRING ON THE FISSION PROBABILITIES OF NUCLEI BELOW RADIUM. Moretto, L. G.; Thompson, S. G.; Routti, J.; Gatti, R. C. (Univ. of California, Berkeley). Phys. Lett.; 38B: No. 7, 471-4(3 Apr 1972).

Realistic level densities were employed in analyzing experimental fission probabilities. The inclusion of shell and pairing effects allows one to obtain reliable information concerning the fission barriers as well as the saddle-point pairing and level densities. (auth)

29691 NUCLEAR DATA SHEETS FOR A = 197. Lewis, M. B. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B; 7: No. 2, 129-60(Feb 1972).

Level schemes, spin and parity assignments, and decay properties are presented for all nuclei with mass number A = 197. Experimental data and adopted values are given along with conclusions as to the spin and parity assignments. The presentation of the nuclear properties is given in the light of the data and current theoretical ideas. In this transition region, level decay rates are seen to be of particular importance and so have been summarized in terms of multipole enhancement or hindrance. Some of the more important deficiencies in the data include the reaction data leading to ^{197}Pt and the decay mode of ^{197m}Pb. Compilers have attempted to bring out some inconsistencies in the data and resolve discrepancies when possible. (auth)

29692 NUCLEAR DATA SHEETS FOR A = 194. Auble, R. L. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B; 7: No. 2, 95-127(Feb 1972).

Nuclear structure data for the A = 194 mass chain are compiled, and adopted level properties and decay schemes are

presented. In addition, several problem areas are noted and discussed. These include β-intensities from ^{194}Os decay, correlation of low-energy γ-transitions in ^{194}Ir reported in thermal-neutron capture and 31-ms ^{194m}Ir decay, energies of metastable states in ^{194}Ir, multipolarities for gamma rays from 31-ms ^{194m}Ir decay, B(E2)-values and g-factors for ^{194}Pt levels. (auth)

29693 INTERNAL IONIZATION OF THE K SHELL ACCOMPANYING BETA DECAY OF ^{204}Tl. Mord, Allan John. Eugene, Oreg.; Univ. of Oregon (1971). 74p. University Microfilms Order No. 72-8578.

Thesis.

The spectrum of electrons emitted during internal ionization of the K shell of ^{204}Tl has been studied. Thallium-204 decays by first-forbidden unique beta decay ($\Delta J = 2$, parity change). This class of decay permits a sensitive test of the prediction, contained in the theory of Stephas and Crasemann, that the beta-decay shape factor is modified by the requirement that the wavefunction of the two emitted electrons be antisymmetric. X-ray-electron coincidence measurements were performed. Data are presented in the format $P_K(E) = N_v(E)dE/N_e(E)dE$, where $N_v(E)dE$ is the number of K-shell vacancies created at the same time that an electron with energy between E and E+dE is detected, and $N_e(E)dE$ is the total number of β particles and ejected electrons detected with energies between E and E+dE. Six data points were obtained, with approximately 5% standard deviation. The probability of ^{204}Tl K-shell ionization accompanying electrons with energy greater than 78 keV was found to be $(1.037 \pm .034) \times 10^{-4}$ per beta decay. The atomic matrix element which is a factor in the internalionization transition amplitude has been reexamined. Calculations with relativistic wavefunctions performed to date were based on an approximate form of the matrix element. This approximate form diverges at low electron momentum, such that the integral for the total transition probability does not exist. In the present work, an exact form of the relativistic hydrogenic matrix element has been derived in an attempt to avoid this divergence. Numerical calculations using this exact form have not yet been performed. The spectrum of emitted electrons and the quantity $P_K(E)$ were calculated, using unscreened, nonrelativistic hydrogenic wavefunctions. The shape of the calculated $P_K(E)$ curve matches the experimental data only if the ordinary (unmodified) form of the beta-decay shape factor is used. The importance of the ratio of density-of-states factors is verified. The observed magnitude of the quantity $P_K(E)$ exceeds the calculated magnitude by a factor of approximately 3.5. This discrepancy is tentatively attributed to the neglect of relativity and screening in the wavefunctions. (Diss. Abstr. Int., B)

29694 NUCLEAR DATA FOR A = 206 ISOBARS. Seth, Kamal K. (Northwestern Univ., Evanston, Ill. Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B; 7: No. 2, 161-207(Feb 1972).

Nuclear data relating to nuclear isobars with A = 206 are presented. When new data with better accuracy are available, older data are often not quoted but only referred to. Similarly, only the latest data from an author are quoted when the measurement has been reported several times. From the cumulative data presented, conclusions about level energies, spins and parities are derived. Decay schemes, γ-ray properties and other properties of nuclear levels are also presented, whenever pertinent data are available. The schematic relation of isobars of A = 206 is presented as a summary of the entire chain. Since very good theoretical calculations are now available for two-hole states in A = 206 nuclei, these theoretical results are presented in Drawing 2 together with the adopted level schemes for ^{206}Tl (1 proton−1 neutron hole) and ^{206}Pb (2 neutron holes). For ^{206}Hg no experimental data are available. For $Z \geq 83$ no results of theoretical calculations are presented. The only available calculation for ^{206}Bi is suspect because of problems revealed in a similar calculation for ^{209}Bi. A number of serious gaps in the available data are exposed, and attention is drawn to the possible experiments. Similarly, experiments which have been reported previously but need to be done with greater precision are given. Some of these experiments are being attempted currently. Details of assumptions involved and parameters used in DWBA analyses of reactions have not been presented. (auth)

29695 5.5 MeV ANOMALOUS GAMMA RADIATION IN ^{205}Tl $(n,\gamma)^{206}$Tl. Earle, E. D. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Lone, M. A.; Bartholomew, G. A.; (and others). pp 263-70 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The anomalous 5.5-MeV γ radiation in the ^{205}Tl(n,γ) reaction was studied to determine the magnitude and neutron energy dependence of the anomaly. Both low- and high-energy γ spectra were measured for neutron energies up to 220 keV. Resonance parameters were determined for 90 resonances between 1.2 and 220 keV. Evidence was found for an enhancement of 5.5-MeV γ-rays for strong s-wave resonances. (J.W.R.)

29696 PRODUCTS OF THE REACTION $^{12}C + ^{209}Bi$. Bell, J. C.; Grant, I. S.; Gregory, K.; Williams, R. J. (Univ. of Manchester, Eng.). pp 489-95 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

Excitation functions for the production of $^{214-218}$Ac in the ^{209}Bi $(^{12}C,xn)$ reaction have been measured at bombarding energies from the Coulomb barrier to 115 MeV. Calculations taking fission and grazing reactions into account give cross-sections for the spallation products in satisfactory agreement with experiment. Mass distributions of Nb, Cd and Sb fission fragments in this reaction support the UCD hypothesis. Measurements of the total energy carried away from fission fragments suggest that the initial spin of a typical fragment varies appreciably with bombarding energy. (auth)

29697 YRAST TRAPPING IN HEAVY ION COMPOUND NUCLEUS REACTIONS. Gough, Richard A.; Macfarlane, Ronald D. (Texas A and M Univ., College Station). pp 497-504 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The compound nucleus, ^{221}Ac, was studied in the heavy-ion reactions: $^{209}Bi + ^{12}C$, $^{207}Pb + ^{14}N$, and $^{205}Tl + ^{16}O$. Targets of 100 to 300 $\mu g/cm^2$ were bombarded by heavy ions of 5 to 10 MeV/nucleon. The short-lived α-emitting products were identified by their characteristic α decay properties. Excitation functions for (H1,xn) reactions were determined. The data were studied to determine whether compound nucleus reactions in this region are sensitive to the predicted high density of low-energy high-spin states. Yrast trapping effects were observed. (J.W.R.)

29698 $1/2^+$ PARTICLE-VIBRATION DOORWAYS IN COMPOUND NUCLEI ^{209}Pb AND ^{207}Pb. Divadeenam, M. (North Carolina Central Univ., Durham. Triangle Universities Nuclear Labs., Durham, N. C.); Beres, W. P. pp 575-87 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The particle-vibration model is used for describing the resonances observed in ^{206}Pb and ^{208}Pb neutron scattering experiments. The model adequately describes the $1/2^+$ states of the ^{207}Pb and ^{209}Pb compound nuclei. (J.W.R.)

29699 s- AND p-WAVE NEUTRON SPECTROSCOPY. PART Xb. INTERMEDIATE STRUCTURE, ^{48}Ca, ^{207}Pb. Seibel, F. T.; Bilpuch, E. G.; Newson, H. W. (Triangle Universities Nuclear Lab., Durham, N. C. Duke Univ., Durham, N. C.). Ann. Phys. (N. Y.); 69: No. 2, 451-62(Feb 1972)..

An improved method for fitting total cross section curves with an R-matrix code was developed which allows the interpretation of data which were previously considered too complicated for analysis. The widths of the $1/2^+$ resonances of ^{207}Pb were determined well enough to confirm the sum rule which should hold if the isolated $1/2^+$ resonance in ^{208}Pb acts as a doorway state for both ^{207}Pb and ^{206}Pb. New data are included on the total cross section of ^{48}Ca, which is remarkable in that the resonances seem very close in energy and sometimes in width to those of oxygen. Furthermore, the calculations in the previous paper (Part Xa) predict correctly that there will be no observable s-wave resonances and also that most of the non s-wave resonances should be due to d waves. These predicted J values are definitely confirmed for 4 out of 7 resonances and are consistent with all the data. (4 figures) (auth)

29700 HYPERFINE STRUCTURE AND ISOMERIC SHIFT OF ^{199} Hg. Covey, Robert L.; Davis, Sumner P. (Univ. of California, Berkeley). Phys. Rev., C; 5: No. 4, 1397-1402 (Apr 1972).

The optical hyperfine structure and isotope shift in the 2537-Å line were investigated. Two of the three components were observed and measured. The magnetic-dipole-splitting factor $A(^3P_1)$ is -0.0771 ± 0.0005 cm^{-1} and the isotope shift $\Delta S(^1S_0)$ is 0.112 ± 0.006 cm^{-1} with respect to ^{198}Hg. The shift indicates staggering toward the heavier even isotope. An explanation is given in terms of nuclear deformation. (5 figures, 1 table) (auth)

29701 PRODUCTION OF THE NEW ISOTOPE ^{216}Pa BY BOMBARDING OSMIUM WITH PHOSPHORUS AND GOLD WITH

MAGNESIUM. Sung-Tsing-Yang, G. Ya.; Druin, V. A.; Trofimov, A. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 6, 1297-9(Dec 1971). (In Russian).

A 310-cm cyclotron was utilized to accelerate a beam of P^{6+} ions (10^{13} particles/sec) to an energy of 200 MeV for the purpose of studying the interaction of such a beam with ^{189}Os and ^{190}Os to yield ^{235}Pa. Similarly, a Au target was bombarded with ^{24}Mg ions to obtain the reaction ^{197}Au (^{24}Mg,5n)^{216}Pa. $T_{\frac{1}{2}}$ for ^{216}Pa was 0.20 ± 0.04 sec. (K.S.W.)

29702 DECAY OF ^{205}Bi AND ^{204}Bi. Hnatowicz, V.; Kristak, J.; Connor, R. D. (Univ. of Manitoba, Winnipeg). Nucl. Phys.; A185: No. 2, 601-13(1972).

High-resolution γ-ray studies have shown the decay patterns of ^{205}Bi and ^{204}Bi to be very complex with 79 γ-rays assigned to the former decay and 169 to the latter. Conversion coefficients were calculated for 17 transitions in ^{205}Pb and 56 in ^{204}Pb and are compared with earlier results. Spin and parity assignments are given on the basis of the multipolarities of de-exciting transitions. Level schemes are discussed for both decays. (auth)

29703 HYPERFINE INTERACTIONS OF Pt NUCLEI RECOILING INTO HELIUM AND VACUUM. Speidel, K.-H. (Univ., Bonn); Doubt, H. A.; Fechner, J. B.; Hagemeyer, K.; Kleinfeld, A. M. Nucl. Phys.; A185: No. 2, 403-12(1972).

Perturbed γ-ray angular distributions were measured for Coulomb excited $^{194,195,196,198}Pt$ recoiling into He and vacuum at v/c = 0.010. Calibration of the hyperfine field yielded the following g-factors: g(240 keV, $5/2^-$; ^{195}Pt) = 0.22 ± 0.04; g(407 keV, 2^+; ^{196}Pt) = 0.29 ± 0.06. Ratios of g-factors were also obtained directly from the perturbation parameters of the even nuclei and a new behavior of the hyperfine interaction at low gas pressures was observed. The hyperfine field and its atomic structure dependence is compared to previous results. (auth)

29704 NUCLEAR MAGNETIC RESONANCE ON ORIENTED ^{195m}Pt IN IRON. Bacon, F.; Kaindl, G.; Mahnke, H.-E.; Shirley, D. A. (Univ. of California, Berkeley). Phys. Rev. Lett.; 28: No. 12, 720-2(20 Mar 1972).

The magnetic hyperfine splitting of ^{195m}Pt(Fe) was determined by the technique of nuclear magnetic resonance on oriented nuclei as $\mu H/hI$ = 89.5 ± 0.5 MHz. With additional γ-ray anisotropy data for the 129- and 99-keV γ rays, we derived the spin, $I = 13/2$, and the magnetic moment of the isomeric state, $\mu(13/2) = \pm(0.597 \pm 0.015)\mu_N$, as well as the E2/M1 mixing ratio of the 99-keV γ transition, $\delta = -0.16 \pm 0.02$. (auth)

29705 FISSION OF U, Bi, Au, AND Ag INDUCED BY 29-GeV ^{14}N IONS. Katcoff, S.; Hudis, J. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 28: No. 16, 1066-8(17 Apr 1972).

The binary fission cross sections measured with mica track detectors are threefold larger than with protons of 29 GeV. Ternary events are ~1% of binary. With U, Bi, and Au there is little preference for emission of fragments into the forward hemisphere. There is no indication of interactions which involve large momentum transfers to heavy target nuclei from 29-GeV ^{14}N ions. However, with Ag targets there is evidence of significant momentum transfer. (auth)

Nuclear Properties and Reactions, A ≥ 220

Refer also to abstracts 27968, 29654, 29665, 29705, 29738, and 29776.

29706 (ORNL-TM-3707) MULTILEVEL ANALYSES OF THE ^{235}U FISSION AND CAPTURE CROSS SECTIONS. de Saussure, G.; Perez, R. B.; Kolar, W. (Oak Ridge National Lab., Tenn.). Mar 1972. Contract W-7405-eng-26. 56p. Dep. NTIS.

The neutron capture and fission cross sections of ^{235}U were analyzed up to 60 eV with the multilevel formalism of Reich and Moore. The statistical distribution of the R-matrix parameters obtained in this analysis was investigated in detail. After corrections for the "missed levels," the observed statistical distributions of the parameters and level spacings agree well with the expected Porter–Thomas distributions and Wigner law, respectively. The average values of the resonance parameters do not agree for the same cross sections with the values obtained by other authors on the basis of the single-level formalism. The set of resonance parameters obtained in this work was used to compute the fission cross section at liquid nitrogen temperature, for comparison with existing measurements, and to "mock-up" the cross sections in the unresolved resonance region near 1 keV, where S-wave processes still dominate. (auth)

29707 (RLO-2227-T-7-8) NUCLEAR CHEMISTRY PROGRESS REPORT, MARCH 15, 1971–MARCH 15, 1972. Loveland, Walter D. (Oregon State Univ., Corvallis). Mar 1972. Contract AT(45-1)-2227. 41p. Dep. NTIS.

ANTIMONY-123—energy levels from tin-133 decay, spin-parity assignments for, (E) p 21-25
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—angular momenta of, mass ratio dependence in californium-252 spontaneous fission, (E) p 15
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URANIUM-235—neutron fission of, γ-ray yield from thermal, p 19-20 (J.W.R.)

29708 CAPTURE AND FISSION GAMMA RAYS FROM EPITHERMAL NEUTRON IRRADIATION OF ^{235}U. Graves, Robert Gage. Stony Brook, N. Y.; State Univ. of New York (1971). 136p. University Microfilms Order No. 72-5738.

Thesis.

Capture and fission gamma rays from epithermal neutron irradiation of ^{235}U have been identified, the former for the purpose of determining the level structure of ^{236}U and the spins of the resonances formed in epithermal neutron capture. The criterion used to identify capture and delayed fission gamma rays involved comparing two gamma ray spectra: one a "capture plus background" spectrum containing capture, prompt and delayed fission, and other background gamma rays, and the other a "background only" spectrum containing mostly delayed fission and other background gamma rays, and weak resonant capture and prompt fission gamma rays. Coincidence spectra taken with a large 4π fission neutron detector and Ge(Li) crystal were used to identify prompt fission gamma rays, as one is not able, by the comparison method alone, to distinguish between capture and prompt fission gamma rays. As the capture gamma ray spectra from individual resonances were severely contaminated with fission gamma rays, an attempt was made by utilizing the fission neutron detector to reduce the background due to prompt fission gamma rays. The delayed radiation was so intense, however, that gamma ray spectra in which the prompt radiation had been reduced were nearly identical to the gamma ray spectra in which the prompt radiation had not been reduced. Energies of high energy gamma rays identified as due to resonant neutron capture in ^{235}U, i.e., capture gamma rays, are 6396, 5588, 5546, 5487, 5417, and 5292 keV; these populate excited states in ^{236}U at 149, 957, 999, 1058, 1128, and 1253 keV relative to the ground state of ^{236}U. Many of the 14 low energy gamma rays identified as capture have been assigned as those representing transitions between these low lying excited states. On the basis of observing the 5588 keV gamma ray, which populates a 2^+ final state in ^{236}U, the spin-parity of the 2.040, 6.39, 12.39, 14.53, and 32.05 eV resonances has been assigned as 3^-. From the work of Schermer et al., and the 3^- assignment for the 2.040 eV resonance, it is concluded that the 0.290 and 1.14 eV resonances are 3^- and 4^-, respectively. Using recommended resonance parameters, the above six 3^- resonances have an average fission width of 34 ± 23 MeV, compared with 48 ± 12 MeV for all 51 3^- and 4^- resonances. Assuming that the distribution of fission widths for the 3^- resonances is chi-square with two degrees of freedom and the distribution of fission widths for both 3^- and 4^- resonances is chi-square with four degrees of freedom, it is found that for the six resonances which were determined to be 3^- and the 51 resonances with recommended fission widths, $\langle\Gamma_f(J^\pi = 3^-)\rangle = (0.58^{+0.49}_{-0.21})\langle\Gamma_f(J^\pi = 4^-)\rangle$. This relationship is not consistent with the relationship based on the Bohr theory of fission using the presently known properties of the transition states. On the basis of level systematics in even uranium isotopes and the high and low energy capture gamma rays, it is proposed that the 1128 keV level in ^{236}U is most likely the 5^+ member of the K^π, $J^\pi = 2^+$, 2^+ γ-vibrational band. (Diss. Abstr. Int., B)

29709 SUPERHEAVY ELEMENT SYNTHESIS. Meldner, H. W. (Univ. of California, San Diego, La Jolla). Phys. Rev. Lett.; 28: No. 15, 975-8(10 Apr 1972).

It is proposed to overcome the present difficulties of superheavy-element production by utilizing neutron capture at time constants between those associated with "prompt" and "rapid" processes, i.e., by employing suitably controlled thermonuclear explosives. (auth)

29710 NEUTRON RESONANCE ANALYSIS CODE BY LEAST-SQUARES METHOD. Sakakibara, Shyoji; Yamamuro, Nobuhiro (Tokyo Inst. of Tech.). Mem. Chubu Inst. Technol.; 7: No. 12, 143-8(Dec 1971).

To determine accurately not only the neutron width but also the radiation width, a neutron resonance parameter analysis code, based on the code TACASI, that could treat simultaneously transmission area, capture area, self-indication area, and self-indication ratio was programmed. A test calculation of this code was made for the 23.52-eV resonance of ^{232}Th. As the result of this calculation, the accuracy of the neutron width was obtained within a few percent, but that of the radiation width was poor because of the lack of the multiple scattering correction in the code. To obtain the accuracy of resonance parameters within a few percent, more than several data must be used, if the observed uncertainties are 3 to 4 percent. This code was programmed for the purpose of finding new resonances and determining more accurate resonance parameters. The multiple scattering correction term will be added to this code shortly. (3 figures, 5 tables) (auth)

29711 HIGH-RESOLUTION CROSS SECTION MEASUREMENT FOR ^{236}U(n,f). Roesler, H.; Plasil, F.; Schmitt, H. W. (Oak Ridge National Lab., Tenn.). Phys. Lett.; 38B: No. 7, 501-3(3 Apr 1972).

The cross section for neutron-induced fission of ^{236}U was measured in the region of the fission threshold, with 7 keV resolution, for neutrons in the energy range 0.5 to 2.6 MeV. Cross-section maxima are observed at 0.75, 0.95, 1.15, and 1.4 MeV. It is possible that these peaks correspond to collective levels in the second minimum of the potential-energy barrier for fission. (auth)

29712 TOTAL SPONTANEOUS AND ISOMER FISSION HALF-LIVES OF ^{234}U, ^{236}U, AND ^{240}Pu. Hooshyar, M. A. (Univ. of Maryland, College Park). Phys. Lett.; 38B: No. 7, 495-8(3 Apr 1972).

The observed absolute yield curves, total decay probabilities from the spontaneous and the isomeric fission states of ^{234}U, ^{236}U, and ^{240}Pu, and the average kinetic energies were calculated by using the recently proposed coupled-channel decay theory. The predicted yield curve for the decay of isomer fission state seems to be in agreement with preliminary observation. (auth)

29713 MEASUREMENT OF TOTAL DELAYED-NEUTRON YIELDS AS A FUNCTION OF THE ENERGY OF THE NEUTRON INDUCING FISSION. Krick, M. S.; Evans, A. E. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng.; 47: No. 3, 311-18 (Mar 1972).

Total delayed-neutron yields from ^{233}U, ^{235}U, ^{238}U, ^{239}Pu, and ^{242}Pu were measured as a function of the energy of the neutron inducing fission. The measurements extend from 0.1 to 6.5 MeV for ^{233}U and ^{235}U, from 1.6 to 6.5 MeV for ^{238}U, from 0.1 to 1.8 MeV for ^{239}Pu, and from 0.7 to 1.3 MeV for ^{242}Pu. No variation in yield with energy for any of these isotopes was found below 5 MeV. Between 5 and 6.5 MeV the yields for ^{233}U, ^{235}U, and ^{238}U were found to decrease by approximately 30%. The absolute yield for ^{242}Pu was measured for the first time, resulting in a value of 0.016 ± 0.005 delayed neutrons per fission. The average energies of the delayed neutrons from ^{233}U, ^{235}U, ^{239}Pu, and ^{242}Pu were estimated to be slightly less than 0.5 MeV for fissioning neutron energies below 1.8 MeV. These delayed-neutron results are generally consistent both with earlier measurements and qualitative theoretical predictions. (auth)

29714 POPULATION OF 0^+ STATES IN ACTINIDE AND A ≈ 190 NUCLIDES BY THE (p,t) REACTION. Maher, J. V. (Argonne National Lab., Ill.); Erskine, J. R.; Friedman, A. M.; Siemssen, R. H.; Schiffer, J. P. Phys. Rev., C; 5: No. 4, 1380-9 (Apr 1972).

The (p,t) reaction was studied for targets of ^{230,232}Th, ^{234,236,238}U, ^{242,244}Pu, ^{248}Cm, ^{182,184,186}W, and ^{196}Pt. Uniformly strong (~15% of ground-state cross section) transitions were found to populate excited 0^+ states in all of the actinide nuclides. The observed 0^+ states were previously known for five of the actinide nuclei, and in these cases the states were characterized by small α-decay hindrance factors and large E0 matrix elements. They have been previously classified as β vibrations. The strong excitation of the 0^+ states in the (p,t) reactions, combined with all other available evidence, suggests that throughout the actinide mass range these 0^+ states represent a stable collective excitation different in character from both the β vibration and the most common formulation of the pair vibration. No such excitations were seen in the W–Pt region. (12 figures, 4 tables) (auth)

29715 NEUTRON EVAPORATION AND ENERGY DISTRIBUTION IN INDIVIDUAL FISSION FRAGMENTS. Iyer, M. R.; Ganguly, A. K. (Bhabha Atomic Research Centre, Bombay). Phys. Rev., C; 5: No. 4, 1410-21(Apr 1972).

By using the isotopic probability distributions of fragments as given by a model for the fission process and those of products as calculated from published product charge distribution parameters, a new procedure is developed for obtaining the number of neutrons $\bar{\nu}(Z,N)$ evaporated from individual fragments of ^{235}U(n_{th},f). By following neutron evaporation as a cascade process and applying Weisskopf's evaporation theory to each step of the cascade, the excitation energy carried by the individual fragments is solved from the $\bar{\nu}(Z,N)$ data. This procedure also gives an estimate of the fission γ energy from individual fragments without an a priori assumption. The kinetic energy for each fragment is calculated from the total fission energy obtained using a mass formula and the computed excitation energy. Isobaric, isotopic, and isotonic averages of the parameters are presented. The distributions of $\bar{\nu}(Z,N)$ versus N for a given Z show shell effects at neutron magic numbers N = 50 and 82. The maximum in isobaric average excitation energy for fragment pairs is found to occur a few mass units away from the point of symmetry, similar to such a trend observed in experimental $\bar{\nu}(A)$ for fragment pairs. The isotopic probability distributions given by the model do not take cognizance to any specific shell effects. However, from the minima in $\bar{\nu}(Z)$ and $\bar{\nu}(N)$ distributions in the region of magic numbers and the occurrence of peaks in the complementary regions, it is concluded that, in fission events when a magic-number fragment is involved, the major part of the excitation energy is carried by the complementary fragment. The isobaric average kinetic energy distribution in the present work reproduces many of the fine structures in the experimental curve; however, the dip at the point of maximum excitation energy is not noticed in the latter. The fission-neutron spectrum in the laboratory frame is calculated from the spectra of evaporated neutrons from individual fragments and compared with the Watt spectrum. Average fission parameters obtained in the present work are in good agreement with experimental results. (9 figures, 2 tables) (auth)

29716 EMISSION OF ALPHA PARTICLES IN THE FISSION OF ^{238}U BY 16- AND 42-MeV PROTONS. Rajagopalan, M.; Thomas, T. D. (Princeton Univ., N. J.). Phys. Rev., C; 5: No. 4, 1402-9(Apr 1972).

The rate of emission of α particles in coincidence with fission was measured for ^{238}U bombarded with protons of energy 16 and 42 MeV. There is a significant increase in the number of α particles per fission over this range. Part of this increase is due to contributions from the (p,αf) reaction. After corrections are made for this process, however, there remains an increase of about 20% in the probability for the (p,fα) reaction between the low- and high-energy measurements. These results together with those of others can be summarized by the formula $Y_\alpha = 1.82 \pm 0.13 + (0.019 \pm 0.006)E^*$, where Y_α is the number of long-range α particles per thousand fissions and E^* is the excitation energy. This dependence on energy can be understood by assuming that the α particles arise from the fragments that are most deformed at the scission point. Although the average deformation at scission remains approximately constant with excitation energy, the spread in the distribution of deformations and, hence, the number of configurations with high deformation, may increase with excitation energy. The angular correlation between fission fragments and α particles near 90° is independent of the excitation energy; at 180°, however, there is a marked increase in the number of coincidences as the excitation energy is increased. (6 figures) (auth)

29717 REACTIONS OF PROTONS WITH ^{231}Pa AND ^{232}Th. Hahn, R. L.; Toth, K. S.; Roche, M. F. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A185: No. 1, 252-62(1972).

Yields of α-radioactive products from reactions induced in ^{231}Pa targets by protons from 35 to 63 MeV were measured by recoil-collection techniques. The results, as similarly observed by Lefort and co-workers for the reactions of ^{232}Th + p at energies ≦ 85 MeV, indicate that the yields of reactions involving charged-particle emission are comparable to or larger than those involving only neutron emission. In addition, the experimental yield curves exhibit high-energy tails. Results for both the ^{231}Pa and ^{232}Th targets are compared with the predictions of nuclear-reaction calculations

that take into account the competition between fission and particle emission. Bearing in mind the assumptions inherent in the calculations and the fact that no parameters were fitted to the data, we found that the compound-nucleus model, with fission, did not account for the experimentally observed trends. The intra-nuclear cascade model, including fission competition in the compound-nuclear de-excitation phase, on the other hand, predicted excitation functions that were reasonably consistent with the results for (p,xn) and (p,pxn) reactions. Neither model was successful in accounting for the (p,α3n) data. In the case of ^{221}Pa results, it was found that recoil-range effects had to be included in the nuclear-reaction calculations. (auth)

29718 RELATIVE X-RAY TRANSITION PROBABILITIES TO THE K-SHELL FOR Z = 81, 92, 94, AND 96. Schmidt-Ott, W.-D.; Hansen, J. S.; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Z. Phys.; 250: No. 3 191-7(1972).

Accurate intensity measurements of the major K x-ray groups have been performed with high resolution Ge(Li) detectors in singles and coincidence arrangements and with a high-purity Ge detector of the intrinsic type. Previously reported K x-ray intensities for Z = 96 are in error due to the presence of a 121.5 keV γ-ray in the decay of ^{249}Cf. The present results are as follows: for Z = 81, $K_{\alpha_2}/K_{\alpha_1}$ = 0.589 ± 0.008, $K_{\beta_2'}/K_{\alpha_1}$ = 0.344 ± 0.008, $K_{\beta_1'}/K_{\alpha_1}$ = 0.102 ± 0.004, and K_β/K_α = 0.281 ± 0.006; for Z = 92 $K_{\alpha_2}/K_{\alpha_1}$ = 0.611 ± 0.008, $K_{\beta_2'}/K_{\alpha_1}$ = 0.365 ± 0.008, $K_{\beta_1'}/K_{\alpha_1}$ = 0.125 ± 0.004, and K_β/K_α = 0.300 ± 0.006; for Z = 94, $K_{\alpha_2}/K_{\alpha_1}$ = 0.610 ± 0.008, $K_{\beta_2'}/K_{\alpha_1}$ = 0.369 ± 0.010, $K_{\beta_1'}/K_{\alpha_1}$ = 0.127 ± 0.004, and K_β/K_α = 0.308 ± 0.008; and for Z = 96, $K_{\alpha_2}/K_{\alpha_1}$ = 0.627 ± 0.008, $K_{\beta_2'}/K_{\alpha_1}$ = 0.372 ± 0.009, $K_{\beta_1'}/K_{\alpha_1}$ = 0.133 ± 0.005, and K_β/K_α = 0.310 ± 0.008. The error limits are the 2σ statistical errors to which a systematic error in the detector efficiencies has been added linearly. The present results are compared with recent theoretical calculations. (auth)

29719 METHOD OF MEASURING RELATIVE NEUTRON CAPTURE RATE OF ^{238}U BY FOIL ACTIVATION. Tasaka, KanjiKoyama, Kinji; Sasamoto, Nobuo; Takeuchi, Motoyoshi (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 8: No. 12, 720-4(Dec 1971).

The γ spectra of irradiated uranium samples around the 106.1-keV photopeak was studied to establish a method for determining the relative neutron capture rate of ^{238}U. (M.C.G.)

29720 SOME FORMULAS FOR INELASTIC SCATTERING CROSS SECTIONS OF NEUTRONS. (SPIN OF GROUND STATE) = 0. Ohta, Masao (Kyushu Univ., Fukuoka); Nishihara, Hiroshi. Kyushu Daigaku Kogaku Shuho; 44: No. 3, 291-8(Jun 1971). (In Japanese).

Some formulas for inelastic scattering cross section of neutrons, which are important to evaluate nuclear properties and economy of fast neutron reactors, were obtained for scattering due to discrete levels of $^{56}_{26}$Fe, $^{232}_{90}$Th, and $^{238}_{92}$U. A method developed by Hauser and Feshbach was used where compound nuclei model was assumed. Calculation was performed for excitation to certain levels from ground 0^+ level. Numerical calculation of the cross section due to excitation to first excited state of ^{56}Fe was carried out, and compared with other data. The result showed that contribution from higher partial waves was large. Since impedance mismatching between inner and outer parts at the nuclear surface became large for large depth of potential Vo, waves were reflected at the time of formation and disintegration of the compound nuclei, and penetration factor Tl became small. Then, the cross section was reduced. Result of trial calculation was close to other data. The present formula did not include effects of competing processes and others. (Japan)

29721 NUCLEAR CHARGE DISTRIBUTION IN FISSION: FRACTIONAL INDEPENDENT YIELD OF ^{140}La FROM THERMAL-NEUTRON INDUCED FISSION OF ^{249}Cf. Troutner, D. E.; Harbour, R. M. (E. I. du Pont de Nemours and Co, Aiken, S. C.). J. Inorg. Nucl. Chem.; 34: No. 3, 801-9(Mar 1972).

The fractional independent yield of ^{140}La from the thermal-neutron induced fission of ^{249}Cf was measured by two methods. In one method, the change in activity as a function of time of the 1596.2-keV gamma ray from ^{140}La was measured with a Ge(Li) detector in the presence of the gross fission products. In the other method, ^{140}La was chemically separated from ^{140}Ba at known times after fission and its gamma activity was measured. The weighted mean of the yields from the two methods was 0.035 ± 0.001. This yield is consistent with other yields from ^{249}Cf and ^{252}Cf fission, which show there may be less redistribution of charge during fission of ^{249}Cf and ^{252}Cf than during fission of ^{233}U and ^{235}U. The most probable charge, Z_p, for A = 134, 136, 138, and 140 appears to be 0.3 to 0.4 charge units closer to unchanged charge distribution for fission of ^{249}Cf and ^{252}Cf than for fission of ^{233}U and ^{235}U. (auth)

29722 INNER BREMSSTRAHLUNG AND RECOIL RADIATION FROM BETA DECAY OF FISSION FRAGMENTS OF ^{235}U AND ^{239}Pu FISSIONED BY THERMAL NEUTRONS. Sugai, Iwao. Washington, D. C.; George Washington Univ. (1971). 96p. University Microfilms Order No. 72-6261.

Thesis.

Based on classical electrodynamics, the radiated spectra arising from ejected beta particles from the fission fragments of Uranium 235 and Plutonium 239, fissioned by thermal neutrons, and the radiated spectra of these fragment recoils due to beta emission have been determined quantitatively. This work presents complete radiation spectra as a function of the number of beta particles per second and the kinetic energy of the beta rays after a single fission. A statistical model of the population distribution of beta particles from the fragments within a given energy interval is a part of the calculations. Large-scale computer programs have been developed to perform required calculations, treating over 400 fission fragment nuclide individually in 90 fission chains. The cumulative results have been calculated and checked experimentally. Radiated spectra from inner bremsstrahlung are based on Jackson's formula for the intensity of radiation emitted during beta decay and the disintegration rate, which is the solution of the difference-differential equation for each fission fragment of each decay chain. For recoil radiation, Jackson's formula has been generalized to incorporate different masses and charges for recoiling nuclei. The superposition of these two coincident radiations provides a time dependency of decaying radiated intensity which is not existing in the original Jackson's formula. Radiated spectra from inner bremsstrahlung and recoil radiation have been compared with Planck's blackbody radiation to identify equivalent temperatures of radiation sources. The cooling rates of these sources due to radiation alone have been determined numerically as the equivalent temperatures decrease with the elapsed time from fissions. In the first 40 seconds after the fission, the equivalent temperature is reduced to about 70 percent of the initial equivalent temperature from 1.6×10^{10}°K to 1.1×10^{10}°K for both U-235 and Pu-239 for the frequency range from 5.4×10^{16} Hz to 3.5×10^{21} Hz and from 4.8×10^{8}°K to 3.4×10^{8}°K for U-235 and from 3.8×10^{8}°K to 2.7×10^{8}°K for Pu-239 in the frequency range 2.8×10^{8} Hz to 2.7×10^{16} Hz. (Diss. Abstr. Int., B)

29723 PHYSICS OF DELAYED NEUTRONS: RECENT EXPERIMENTAL RESULTS. Keepin, G. Robert (Los Alamos Scientific Lab., N. Mex.). Nucl. Technol.; 14: No. 1, 53-8(Apr 1972).

Absolute delayed neutron yields in the neutron-induced fission of ^{239}Pu, ^{242}Pu, ^{232}Th, ^{233}U, ^{235}U, and ^{238}U were measured as a function of incident neutron energy. The experimental technique used consisted basically of counting the delayed neutrons emitted between neutron pulses from an accelerator. The measured yields were found to be constant over the range of incident neutron energies from thermal up to 4 or 5 MeV. (J.W.R.)

29724 LOW ENERGY PHOTOFISSION OF HEAVY ELEMENTS: EXPERIMENTAL RESULTS. Bramblett, R. L.; Gozani, T.; Ginaven, R. O.; Rundquist, D. E. (Gulf Radiation Tech., San Diego, Calif.). Nucl. Technol.; 14: No. 1, 33-41 (Apr 1972).

The status of the photofission date required for nuclear materials assays based on photonuclear reactions is discussed. At Gulf Rad Tech photofission and photoneutron yield measurements have been done using bremsstrahlung produced with a single-section electron linear accelerator. The neutron yield was measured simultaneously with the photofission yield which was measured using solid state track detectors. Preliminary high resolution results have been obtained, using neutron time of flight and photodisintegration of deuterium, on the spectrum of thick-target bremsstrahlung used. The fission barrier heights obtained are compared with barrier heights from theoretical analysis of spontaneous fission half-lives. (auth)

Nuclear Theory

Refer also to abstracts 29287, 29301, 29304, 29330, 29501, and 30157.

29725 (COO-3235-5) NUCLEAR EXCITATIONS AND REACTION MECHANISMS. Report of Progress to October 31, 1971. (Brown Univ., Providence, R. I. Dept. of Physics). 1 Nov 1971. Contract AT(11-1)-3235. 22p. Dep. NTIS.

A summary of research on nuclear theory is given including S-matrix elements for electron-hydrogen scattering using the inhomogeneous equations method: phase shifts below the n = 2 threshold, position and widths of resonances, scattering lengths,

search for resonances above the n = 2 threshold; three-body methods: formation of an exact DWBA in the separable-potential model of stripping and its extension to the many-body case, extension of the Lovelace method and the Mitra model to include rank-N separable potentials, calculations of cross sections, comparison and properties of wave functions, convergence of the DWBA series, inclusion of tensor forces. Also studied are properties of isovector excitations in nuclei; form factors, transition densities and sum rules for nuclear electroexcitations; radiative transitions in ^{89}Y; s-wave neutron strength function in the A = 90 region; and damping of simple nuclear excitations. (auth)

29726 (EUR–4760) IBM 360 AND IBM 1800 VERSIONS OF THE SHAPE AND AREA ANALYSIS PROGRAMS OF S. E. ATTA AND J. A. HARVEY. Kolar, W. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). 1972. 126p. Dep. NTIS (U. S. Sales Only). EUR B. Fr. 165.-.

The two computer codes originally written in FORTRAN II were rewritten in FORTRAN IV for the IBM 360 and the IBM 1800 computers. Some modifications were made to increase the flexibility. (auth)

29727 (FRNC-TH–156) COMPARATIVE STUDY AND THE INTERPRETATION OF RESONANCES IN THE S AND R MATRICES. APPLICATION TO THE LIGHT NUCLEI: ^5He, ^5Li, AND ^6Li. Kraus, Ludolf (Strasbourg Univ. (France)). 1971. 153p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

It is shown by theoretical analysis that the one-level approximation formalism of the S matrix is more suitable than the usual one-level approximation of the R matrix for the interpretation of the large resonances encountered with light nuclei. The results of experiments aimed at establishing the spectroscopy of ^6Li, ^5He and ^5Li are interpreted in the S matrix. In this way the level scheme of ^6Li is proposed from d–^4He elastic scattering measurements. The $p_{\frac{1}{2}}$ and $p_{\frac{3}{2}}$ states of ^5Li and ^5He were studied from p–^4He and n–^4He elastic scattering experiments. The $\frac{3}{2}^+$ state of ^5Li was obtained from the D(^3He,^3He)D, D(^3He,p)α, ^4He(p,p)^4He, $^3He + d \rightarrow \gamma + {}^5Li$ reactions and the $\frac{3}{2}^+$ state of ^5He was obtained from the ^3H(d,n)α reactions and the d–^3H and n–^4He elastic scattering results. (France)

29728 (JAERI–1198) FP-S: PROGRAM FOR CALCULATION OF ATOMIC DENSITY FOR EACH FISSION PRODUCT NUCLIDE. Tasaka, Kanji; Sasamoto, Nobuo (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). 11 Dec 1970. 24p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The program FP-S was developed for the calculation of atomic density for each FP nuclide. Irradiation and cooling time may be chosen arbitrarily. There are 199 radioactive nuclides and 78 stable nuclides treated in the program. Calculations of atomic densities are performed analytically, using BATEMAN's equation, which describes the cooling behavior of the radioactive nuclide in a decay chain, and its integrated form repeatedly. Two assumptions are used in the calculation; fission yield does not change through the irradiation time, and decay of FP through the capture of neutron is not taken into account. The above assumptions may be removed with the slight modification of the program FP-S. If atomic densities of FP nuclides are computed by the program FP-S, one can calculate the total radioactivity of FP, energy spectrum of β- or γ-ray, and the overall decay heat of FP, etc. (auth)

29729 (JINR–E4-6265) POLARIZATION EFFECTS IN THE ROTATIONAL MOTION OF ODD-MASS NUCLEI. III. ELECTROMAGNETIC PROPERTIES OF ROTATIONAL STATES. Baznat, M. I.; Chernej, M. I.; Pyatov, N. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). Mar 1972. 27p. Dep. NTIS (U. S. Sales Only).

Electromagnetic properties of rotational states in odd-mass nuclei are investigated employing the nonadiabatic rotational model developed in the preceding parts of this series. The equations for the renormalization of collective parameters J, g_R^0 and Q_0 of the even–even core in odd-mass nuclei are given. The general equation for the effective spin gyromagnetic factor g_s^{eff} including the effects of the spin polarization and Coriolis coupling is obtained. The analysis of experimental data in a number of rare-earth nuclei is carried out. (auth)

29730 (JINR–P4-6104) COUPLING IN THE ROTON THEORY. Karadzhov, D.; Mikhailov, I. N.; Nadjakov, E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The coupling forces in the roton theory are taken into account. The equations are derived for the roton operators for the case of three-dimensional rotation in the presence of the coupling and polarization effects. The formulas for the moment of inertia, which was estimated numerically in the Inglis approximation, are obtained. (auth)

29731 (LBL–624) YRAST TABLES. Gough, R. A. (California Univ., Berkeley. Lawrence Berkeley Lab.). Feb 1972. Contract W-7405-eng-48. 289p. Dep. NTIS.

Yrast levels are presented for a broad range of isotopes throughout the nuclear isotope chart. The results of two different types of calculations are given. The first, listed as EJAY, are calculated by an unpublished computer code based on the combinatorial calculations of the complete level density function. The second, listed as EROT, are the yrast levels for a rigid spherical rotor. (J.F.P.)

29732 (LUSY–7101) COMPUTER PROGRAM FOR ACCEPTANCE CALCULATIONS FOR TWO-BODY PHOTOPRODUCTION REACTIONS. Kivikas, Toeivelemb (Lund Univ. (Sweden). Dept. of Physics). Nov 1971. 36p. Dep. NTIS (U. S. Sales Only).

The program ACCEPT, which calculates the effective solid angle, the angular and energy distributions, the effective target thickness for incident and emitted particles, the number of interacting photons in a bremsstrahlung beam of one equivalent quantum for two-body photoproduction reactions, is presented. For the experimental configuration a cylindrical target with vertical axis irradiated with a beam with a circular cross section and a detector with circular aperture is assumed. For the intensity distribution of the incident beam and the efficiency distribution of the detector empirically determined data can be used. (auth) (Sweden)

29733 (NP–19233) SUFFICIENT CONDITIONS FOR SATURATION OF NUCLEAR FORCES. Note No. 341. Calogero, F.; Simonov, Yu. A.; Surkov, E. L. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 17 Nov 1971. 10p. Dep. NTIS (U. S. Sales Only).

Rigorous conditions are reported, that are sufficient to insure the saturation property of nuclear binding energies. Nuclear forces mediated by local two-body static potentials are treated. For certain classes of potentials the validity of these conditions is also necessary for saturation. (auth)

29734 (RLO–1388–619) FISSION BARRIERS FOR LIGHT ELEMENTS (A = 180–212). Mosel, Ulrich (Washington Univ., Seattle); Schmitt, H. W. (Oak Ridge National Lab., Tenn.). [1971]. 11p. Dep. NTIS.

Fission barriers for elements in the mass range A = 180 to 212 were calculated in the two-center shell model using the Strutinsky prescription. The theoretical predictions agree well with recent experimental results. (auth)

29735 (RLO–1388–626) FINITE SIZE EFFECTS IN HEAVY ION SCATTERING. Mosel, Ulrich (Washington Univ., Seattle. Dept. of Physics). [1971]. 37p. Dep. NTIS.

A Hamiltonian for the description of scattering of particles with finite size is derived by using methods common in fission theory. It is pointed out that in a rigorous treatment of heavy ion interactions information about the true potential can be obtained from experimental data only if the inertial parameters are known. In general the inclusion of the finite size of the scattered particles leads to an explicitly energy and angular momentum dependent real potential when the finite size Hamiltonian is reduced to an optical model form. In a phenomenological model estimate it is shown that the observed energy dependence of the optical potential is compatible with the magnitude of finite size effects. Finally some difficulties in the use of the cranking model for the calculation of the inertial parameters are pointed out. (auth)

29736 (RT/FI–(71)29) DIRCO: A FORTRAN PROGRAMME FOR CALCULATION OF DIPOLE RADIATIVE CAPTURE CROSS SECTION ACCORDING TO DIRECT AND COLLECTIVE MODELS. Fabbri, F.; Longo, G.; Saporetti, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 25 Oct 1971. 35p. Dep. NTIS (U. S. Sales Only).

The description of the DIRCO program, written for an IBM 360/75 computer in FORTRAN IV language, is given. The program calculates the dipole nucleon radiative capture cross section according to the direct and collective capture models. (auth)

29737 (TID–25946) FINAL PROGRESS REPORT [ON NUCLEAR PHYSICS AND ASTROPHYSICS], JUNE 1, 1968–AUGUST 31, 1971. (Yeshiva Univ., New York). Contract AT(11-1)-3583. 37p. Dep. NTIS.

Research in nuclear physics and nuclear astrophysics at Yeshiva University in the period June 1, 1968 to August 31, 1971 is summarized. (J.W.R.)

29738 (UCRL-Trans–10583) MONOPOLE ($I^\pi = 0^+$) EXCITATIONS IN EVEN–EVEN DEFORMED NUCLEI. Pyatov, N. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). Translated for Univ. of California, Lawrence Livermore Lab., Livermore, from report JINR–P4-5422. 33p. (CONF-700635–1). Dep. NTIS.

From second symposium on the problems of nuclear physics; Novosibirsk, USSR (12 Jun 1970).

The present status of theoretical and experimental study of the monopole ($I^{\pi} = 0^{+}$) excitations in even nuclei in the ranges $150 \leq A \leq 190$ and $A \geq 228$ is reviewed. The systematics of known experimental data concerning the properties of 0^{+}-states (energies, ∂, $\rho(E0)$, B(E2), X, etc.) are given. A number of phenomenological and microscopic descriptions of 0^{+}-states in transitional and strongly deformed nuclei is considered. The properties of β-vibrations, pairing vibrations, spin-quadrupole excitations, coherent pairing fluctuations and of a number of other types of 0^{+}-states are discussed. Attention is paid to the appearance in the spectra of the low-lying ($\omega < 2\Delta$) pairs of 0^{+}-states, their properties being rather different. (auth)

29739 RIGID ASYMMETRICAL ROTATOR MODEL WITH MODIFIED MOMENTS OF INERTIA. Fedorov, A. D. (Khabarovsk Polytechnic Inst., USSR). Yadern. Fiz.; 15: No. 1, 36-8 (Jan 1972). (In Russian).

The energy levels $\epsilon_{Ir}(\beta, \gamma)$ of the rigid asymmetrical rotator model are calculated at $\beta = 0.3$ by using a numerical method. The symmetry around $\gamma = 30°$ is found to be broken. The shape and table of ratios $R_{Ir} = \epsilon_{Ir}/\epsilon_{21}$ are given as function of γ at a given value of β. It is predicted that many even–even nuclei must be of an "oblate" form. (auth)

29740 MAGNETIC PROPERTIES OF NEUTRON MATTER. Pfarr, J. (Univ., Cologne). Z. Phys.; 251: No. 2, 152-8(1972).

The energy of interacting neutron matter with spin polarization is calculated in Hartree–Fock approximation by the method of unitary transformations for a hard core and a soft core potential. In addition the magnetic spin susceptibility is given and the possibility of a ferromagnetic transition investigated. It is shown that the effect of the nuclear forces for all densities considered depresses the magnetic spin susceptibility relative to that of the corresponding ideal Fermi gas. (auth)

29741 THEORY OF POLARIZATION IN NUCLEAR REACTIONS AND SCATTERING. Heiss, P. (Univ., Cologne). Z. Phys.; 251: No. 2, 159-67(1972).

A general treatment of polarization effects in two particle reactions is given. The treatment is in close analogy to the procedure presented by Welton, but treats the long ranged part of the Coulomb interaction separately. In this way the difficulties due to the slow convergence of the partial wave expansion for the Coulomb scattering amplitude are avoided. The results are readily applicable to scattering processes of both charged and uncharged particles. (auth)

29742 FIRST AND ZERO SOUND IN NEUTRON MATTER. Nitsch, J. (Univ., Cologne). Z. Phys.; 251: No. 2, 141-51 (1972).

In the framework of the Landau theory transport properties of neutron matter are investigated. An important problem is the propagation of first and zero sound and their damping. It is found that zero sound cannot propagate in neutron star matter because of very strong Landau damping. On the other hand first sound is comparatively weakly damped. The absorption coefficient is small and depends sensitively—just as the viscosity and the relaxation time of quasi-particles—on the temperature. (auth)

29743 EFFECT OF MAGNETIC FIELD MODULATION ON ANGULAR CORRELATIONS. Pokazan'ev, V. G.; Yalyshev, Yu. I. (Ural Polytechnic Inst., Sverdlovsk, USSR). Yadern. Fiz.; 14: No. 6, 1294-6(Dec 1971). (In Russian).

It is proposed to use an rf field, parallel to the constant magnetic field H_0, for perturbing γ angular correlations. This serves to eliminate any influence of the amplitude of the rf field on the width of the magnetic resonance curve being detected according to the angular correlation, and accordingly to estimate the lifetime by the width of the curve. (K.S.W.)

29744 BOOTSTRAP THEORY OF QUASIROTATIONAL SPECTRA. Goswami, Amit (Univ. of Oregon, Eugene); Nalcioglu, Orhan. Nucl. Phys.; A184: No. 2, 658-72(1972).

In a previous paper a self-consistent (bootstrap) theory of vibrations, particularly suited for the description of the anharmonicity of the even nuclear spectra, was developed. The bootstrap idea is combined here with the group theoretical approach. This theory makes it possible to understand the smooth transition from vibrational to rotational spectrum and in particular the quasirotational spectrum that is the intermediate situation. Applications of this theory are made for the quadrupole–quadrupole and the pairing Hamiltonians. The observation is made that the smooth transition from vibrational to rotational spectrum for both cases is very similar. (auth)

29745 Λ_{00} AND Λ_{10} CALCULATIONS OF THE BINDING ENERGY OF NUCLEAR MATTER WITH REALISTIC HARD-CORE NUCLEON–NUCLEON POTENTIALS. Fiset, E. O.; Foster, T. C. (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys.; A184: No. 2, 588-98(1972).

Realistic potentials were used in a many-body Green function calculation of the properties of nuclear matter. The Green function method has the advantage that the single-particle energies are determined by the theory and there is no necessity to develop prescriptions for their calculation. Using the Λ_{10} theory and the Hamada–Johnston potential a binding energy of −4.6 MeV per nucleon was obtained. (auth)

29746 CALCULATION OF COEFFICIENTS OF FRACTIONAL PARENTAGE IN THE T,J SCHEME. Shlomo, Shalom (Nuclear Research Center, Beer Sheva, Israel. Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; A184: No. 2, 545-62(1972).

The one-particle jj-coupling coefficients of fractional parentage of both protons and neutrons were calculated using a recursion relation. The n-particle wave functions obtained from the recursion relation are antisymmetric with well-defined values of total isospin T and total spin J. Appropriate sets of these wave functions were orthonormalized to give wave functions with well-defined seniority v, reduced isospin t, T and J. The calculations were carried out for $j = 1/2, 3/2$ and $5/2$ up to the half-filled shell. Coefficients of fractional parentage for $j = 1/2$ were calculated up to $n = 4$. All coefficients were calculated exactly and are given as roots of rational numbers. (auth)

29747 RELATION BETWEEN PHASE SHIFT, THE BINDING ENERGY, AND THE RANGE OF THE FORCE. Razavy, M.; Krebes, E. S. (Univ. of Alberta, Edmonton). Nucl. Phys.; A184: No. 2, 533-44(1972).

Using energy-dependent boundary conditions for interactions of finite range, a relation between the phase shift, the range, and the binding energy was obtained. This relation was compared with Chadan's single-channel sum rules and it is shown that for few simple cases where sum rules can be calculated analytically the two methods give identical results. Similar relations were derived for multichannel scattering and for potentials with a tail. As an application, the deuteron binding energy was obtained from the triplet neutron–proton phase shifts and the range of the two-nucleon interaction. (auth)

29748 LEVEL DENSITIES FOR RANDOM ONE- OR TWO-BODY POTENTIALS. Gervois, Annie (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Phys.; A184: No. 2, 507-32(1972).

The level density for a given number of particles in one shell was calculated from the grand partition function for random one- or two-body interactions. A Gaussian distribution was found, in agreement with recent numerical results, except for low particle (or hole) density i.e. near closed shells, where the semi-circle law is obtained. (auth)

29749 APPROACH TO NUCLEAR THEORY INCLUDING SHELL-MODEL CONDITIONS AND PARTICLE CORRELATIONS. II. SCATTERING AMPLITUDES AND PHOTONUCLEAR CROSS SECTIONS. Agodi, A.; Baldo, M.; Catara, F.; Di Toro, M.; Parisi, R. (Univ., Catania, Italy. Istituto Nazionale di Fisica Nucleare, Catania, Italy). Nucl. Phys.; A184: No. 2, 458-72 (1972).

A recently proposed approach to the study of nuclear structure was explicitly extended to the continuum in order to describe nuclear reaction processes. Numerical results were obtained for the cross sections of the elastic and inelastic scattering of neutron by ^{15}N and of the (γ,n) reaction on ^{16}O, in the giant-dipole resonance region. The results show strong effects due to the presence of correlations. In particular the fine structure of the giant resonance is satisfactorily accounted for. (auth)

29750 INTERPRETATION OF MASS ASYMMETRY IN FISSION BASED ON DEFORMATION ENERGY SURFACES. Tsang, C. F.; Wilhelmy, J. B. (Univ. of California, Berkeley). Nucl. Phys.; A184: No. 2, 417-36(1972).

The deformation energy surfaces of fissioning nuclei were studied to quantitatively interpret the experimentally observed mass asymmetry in fission. These studies use the calculated deformation energy surfaces that were recently shown to have reflection asymmetric saddle-point shapes in the second (outer) fission barriers of actinide nuclei. Quantitative estimates of the mass asymmetry in fission, characterized by the peak-to-valley mass-yield ratio, were calculated from an analysis of the fission probabilities over the outer barrier. The probability distributions were determined using the simple Fermi-gas level density and the WKB barrier-penetration formulas. Good correlations were obtained for all known radiochemically determined peak-to-valley ratios of doubly even fissioning nuclei for which deformation energy surface calculations are available. This analysis makes it possible to understand the recently discovered apparently anomalous results that the thermal-neutron-induced fission of ^{257}Fm

yields a symmetric mass division while the spontaneous fission of ^{256}Fm is fission asymmetric. A possible explanation for the triple-peaked mass-yield fission of nuclei near ^{226}Ra is proposed based also on the deformation energy surfaces. Further experiments are suggested to test the present theory, in particular, to discriminate between analyses based on the fission barrier in the deformation energy surfaces and those based on fragment shell effects. (auth)

29751 SINGLE-PARTICLE STATES IN NUCLEI. Engelbrecht, C. A.; Weidenmueller, H. A. (Atomic Energy Board, Pelindaba, S. Afr.). Nucl. Phys.; A184: No. 2, 385-416(1972).

From an analysis of experimental data showing structure relating to single-particle motion, a formal definition of single-particle states in nuclei was developed. This definition agrees with and is a generalisation of Landau's quasiparticle concept used in the theory of Fermi liquids. Particular attention is paid to the case of finite nuclei and the averaging procedure needed there. The definition determines energies, widths, wave functions, and the residues (related to the occupation probabilities) of the single-particle states. It is compared with various theoretical definitions of such states, among them the Hartree–Fock and Brueckner–Hartree–Fock definitions. It is emphasised that in comparing single-particle states calculated from the latter two theories with information obtained from the data, it is important to include the off-shell part of the energy-averaged self-energy operator. Previous calculations indicate that this part is not negligible. Various quantities of physical interest, like sum rules for spectroscopic factors and the energy-dependence and nonlocality of the optical model, are discussed in the framework of these results. (auth)

29752 NUCLEON–DEUTERON CAPTURE BELOW THE THREE-NUCLEON BREAK-UP ENERGY. Phillips, A. C. (Univ. of Manchester, Eng. Daresbury Nuclear Physics Lab., Eng.). Nucl. Phys.; A184: No. 2, 337-56(1972).

Radiative nucleon–deuteron capture is considered at energies below three-nucleon break-up. By using wave function and dispersion theory methods it was determined which features of the reaction are independent of the detailed form of the nuclear and electromagnetic interactions. Because of the presence of interaction currents, the experimental cross section for thermal neutron capture is at least twice the theoretical value predicted from the neutron and proton magnetic moments. The energy dependence of the M1 capture amplitudes is shown to be determined by the gross properties of the three-nucleon bound state and the S-wave nucleon–deuteron phase shifts. The E1 capture amplitudes are determined by the known properties of nuclear wave functions. In particular the E1 contribution to the isotropic cross section for p–d capture is shown to depend on the asymptotic properties of the D-states of ^{2}H and ^{3}He and not on the D-state probability densities. If the M1 cross section is normalized at 25 keV, agreement was obtained with all the experimental data on the low-energy p–d capture reaction. (auth)

29753 CONNECTION BETWEEN THE GENERATOR COORDINATE METHOD AND BOSE EXPANSIONS. Holzwarth, Gottfried (Technische Hochschule, Munich). Nucl. Phys.; A185: No. 1, 268-72(1972).

It is shown that the generator coordinate method leads to a Bose expansion which in lowest order agrees with the RPA, and which for infinite order is equivalent to the Marumori expansion. (auth)

29754 STUDIES OF THE MANY-BODY APPROXIMATIONS USING THE PAIRING-PLUS-QUADRUPOLE MODEL. Mustafa, S. M. (Michigan State Univ., East Lansing). Nucl. Phys.; A185: No. 1, 309-20(1972).

Reduced transition probabilities B(E2) for spherical doubly even nuclei are calculated in the quasiboson approximation (QBA), the random-phase approximation (RPA), and the improved random-phase approximation (IRPA). A comparison is made with experiments for each approximation, and the effect of the Pauli principle is demonstrated. The effect of these approximations on the systematics is studied by comparing the average of the absolute deviations from the experimental values for each approximation. The problem is formulated by using double-time Green function techniques. (auth)

29755 MEASUREMENT OF THE NUCLEAR POLARIZATION OF A LOW-ENERGY POLARIZED TARGET BY OBSERVING THE EPR LINE. Kutschera, K.; Kuiper, H.; Kroeniger, D.; Seidler, B. (Univ., Erlangen., Ger.). Nucl. Phys.; A183: No. 3, 593-6000 (1972).

The conventional method of measuring the degree of polarization of a nuclear target (by NMR) cannot be applied to a low-energy polarized target because of its necessarily small size. It is shown that, using a new type of EPR measurement, the nuclear polarization can be derived from an expression of the form $\Delta S = \gamma p$, where ΔS denotes the change of the EPR signal, p the nuclear polarization, and γ a factor which depends on the geometrical dimensions and the crystal structure of the target sample and on a characteristic constant of the measuring apparatus. The dependence of γ on these quantities will be discussed in detail. (auth)

29756 METHOD OF NUCLEAR POLARIZATION MEASUREMENT IN A LOW-ENERGY POLARIZED TARGET BY MEANS OF THE INTERNAL FIELD. Kutschera, K.; Kuiper, H.; Kroeniger, D.; Frank, K.; Seidler, B. (Univ., Erlangen, Ger.). Nucl. Phys.; A183: No. 3, 601-5(1972).

The experimental technique of a new type of polarization measurement especially for use with low-energy polarized targets is described. It is possible to derive the nuclear polarization as well as the nuclear spin-lattice relaxation time from measurements of the internal field. (auth)

29757 MULTIPLE EXCITATION NEAR THE COULOMB BARRIER IN HEAVY ION SCATTERING. Leclercq-Willain, C. (Institut Interuniversitaire des Sciences Nucleaires, Brussels). J. Phys. (Paris); 32: No. 11, 833-40(Nov-Dec 1971).

The semi-classical method developed in Coulomb excitation theory for nuclei is used to describe the inelastic differential cross sections at energies near and above the Coulomb barrier for heavy ion scattering on even–even nuclei possessing vibrational states. The theory is applied to Lemberg's results for 3^- states excited in the scattering of 44.5, 48.5, and 52.5 MeV ^{14}N ions by ^{122}Sn and ^{124}Sn. (France)

29758 DETERMINATION OF THE PARAMETERS OF DECAY SCHEMES. Legrand, J. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 163, 61-5(Oct 1971). (In French).

The utilization of parameters obtained from nuclear decay schemes in the metrology of ionizing radiations is discussed. Two methods are used by the LMRI (Laboratoire de Mesure des Rayonnements Ionisants at Saclay) to obtain these parameters: evaluations from published data; experimental studies. (France)

29759 EFFECT OF NUCLEAR COMPRESSIBILITY ON THE SHELL-MODEL POTENTIAL. Ismail, M. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris); 32: No. 10, 729-31 (Oct 1971).

An interaction model is derived from the nuclear matter saturation curve. This model is used in Hartree–Fock calculations for ^{40}Ca, the nuclear density, single particle energies, and shell-model potential being determined for various compressibility coefficients derived from the nuclear matter saturation curves. (France)

29760 NUCLEAR STRUCTURE IN IDEAL SPACE. Simard, P. A.; Banville, M. (Univ., Sherbrooke, Quebec). Phys. Lett.; 38B: No. 7, 461-3(3 Apr 1972).

The boson method, previously developed for quasi particles, is used to transcribe the shell model Hamiltonian directly from the particle space to the boson space; both the particle number and the Pauli principle are preserved. The method is tested with a calculation of the spectrum of ^{58}Ni. (auth)

29761 NEKOTORYE VOPROSY TEORII STRUKTURY ATOMNYKH YADER. (Problems in Nuclear Structure). Dzhibuti, R. I. (ed.). Tbilisi, USSR; Izdatel'stvo Metsniereba (1971). 71p.

The work reported was performed at the Institute of Physics, GSSR, (1969-70) and pertains to investigations of nuclear structure through the development of special oscillator-shell-model functions and the Brueckner–Hartree–Fock method. A new effective potential was introduced and used to determine a series of properties of three- and four-nucleon nuclei. The convergence in the theory is discussed. A number of photonuclear reactions in light nuclei is examined, and a mechanism for the (γ,np) reaction is reported. (16 figures, 1 table, 114 references) (K.S.W.)

29762 MAGNETIC SUSCEPTIBILITY OF DENSE NEUTRON MATTER. Pandharipande, V. R.; Garde, V. K.; Srivastava, J. K. (Tata Inst. of Fundamental Research, Bombay). Phys. Lett.; 38B: No. 7, 485-6(3 Apr 1972).

The paramagnetic susceptibility of dense neutron matter is calculated for the Reid soft-core potential with the lowest order variational method. No transition to ferromagnetic state is predicted for $k_F < 5$ fm^{-1}. Results of parallel calculations on liquid ^{3}He are also reported. (auth)

29763 INTERFERENCE OF THE TWO CAPTURING STATES IN (n,γ) POLARIZATION EXPERIMENTS. Honzatko, J.; Kajfosz, J. (Nuclear Research Inst., Rez, Czech.). Phys. Lett.; 38B: No. 7, 499-500(3 Apr 1972).

An often neglected effect of interference between two overlapping capturing states in experiments with polarized neutrons and/or oriented nuclei is discussed. (auth)

29764 SPIN AND ISOSPIN EFFECTS IN HIGH-ENERGY PROTON–NUCLEUS ELASTIC SCATTERING AND NUCLEAR CORRELATIONS. Lambert, E.; Feshback, H. (Massachusetts Inst. of Tech., Cambridge). Phys. Lett.; 38B: No. 7, 487-91(3 Apr 1972).

The two-coupled-channel description of nuclear high-energy scattering is extended to include spin and isospin effects. Calculations are presented for the angular distribution of 1-GeV protons scattered by ^{4}He. Sensitivity to dynamical two-body correlations postulated phenomenolcgically or developed by using many-body theory is demonstrated. (auth)

29765 GENERALIZED BOGOLYUBOV–VALATIN TRANSFORMATION OF NEUTRON AND PROTON SYSTEM. Takahashi, Yoshio (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 46: No. 6, 1749-69(Dec 1971).

The charge-independent pairing interaction in a system of neutrons and protons with many j-configurations is studied using the five-dimensional quasi-spin formalism, and the generalized BCS theory is obtained as a natural generalization of the BCS theory of the identical nucleon system. It is shown that a rotation in the five-dimensional quasi-spin space can be regarded as the generalized Bogolyubov–Valatin transformation in the generalized BCS theory. The normalized BCS ground state and the solutions of the BCS equations for several models are explicitly given in analogy to the case of the identical nucleon system. (1 figure, 1 table) (auth)

29766 APPROXIMATION TO THE REACTION MATRIX IN NUCLEAR MATTER. Blatt, D. W. E.; McKellar, B. H. J. (Univ. of Sydney). Aust. J. Phys.; 25: No. 1, 1-7(Feb 1972).

It has been shown by Butler et al., that a good approximation to the Bethe–Goldstone wavefunction can be constructed from eigenfunctions of the free two-nucleon system. The approximation is therefore closely related to the T-matrix. In this paper, it is used to derive an approximate G-matrix in terms of the T-matrix. As an illustration of this approach, the resulting approximate G-matrix is compared with the reference spectrum approximation of Bethe, Brandow, and Petschek for the simple case of a pure hard-core potential. (auth)

29767 AREA ANALYSIS OF NEUTRON AND MOESSBAUER RESONANCES. Malik, S. S. (Univ. of Rhode Island, Kingston); Hanna, S. S. Particles Nucl.; 1: No. 4, 268-74(Jan 1971).

It is shown that formulas given in the literature for area analysis of neutron and Moessbauer resonances give identical results for a wide range of absorber thicknesses within the reported precision of the calculations. In order to relate the existing calculations the only modification required is that the f factors for neutron resonances are unity. The formulas can, of course, be used for all types of resonant absorption and are useful in the case of nonrecoilless gamma absorption. (1 table) (auth)

29768 SPURIOUS ROTATIONAL STATES IN DEFORMED NUCLEAR SHELL MODELS. Fink, Bernd; Kolb, Dietmar; Scheid, Werner; Greiner, Walter (Univ., Frankfurt am Main). Ann. Phys. (N. Y.); 69: No. 2, 375-99(Feb 1972).

A method for projecting spurious rotational states from many-particle nuclear wave functions is extended to wave functions generated by a deformed shell model of axial symmetry. For completeness, the projection procedure is reviewed. According to this method the deformed-shell-model Hamiltonian is altered by a correction term such that the new Hamiltonian $\tilde{H} = H_{SM} - H_{corr}$ is translation- and rotation-invariant; i.e., it depends only on intrinsic coordinates when it is transformed to a body-fixed system. The eigenfunctions of $\tilde{H}$ which are obtained by diagonalizing this Hamiltonian in the shell model basis separate into an intrinsic function and a collective factor depending on the center-of-mass coordinates and Euler angles. By identifying the spurious rotational states this set of functions can be made nonredundant so that the functions are a complete substitute for a set of realistic intrinsic functions. For shell models with axial symmetry only two Euler angles are introduced. It turns out that the intrinsic function is characterized by a good projection of the total angular momentum on the symmetry axis of the nucleus. Applications for the $\Omega^\pi = 0^+$, T = 0 bandheads of ^{20}Ne are given, and good agreement with the experimental spectrum is obtained. A study of the potential energy surface leads to the conclusion that it contains spurious rotational energies. (auth)

29769 DEUTERON D-STATE EFFECTS IN (d,p) AND (p,d) REACTIONS. Johnson, R. C. (Univ. of Surrey, Guildford, Eng.); Santos, F. D. Particles Nucl.; 2: No. 5, 285-325(Nov 1971).

The influence of the deuteron D state on cross sections for (d,p), (d,n), and (p,d) reactions involving deuterons in the energy region 10 to 20 MeV is investigated numerically within the framework of the DWBA. Finite-range effects are taken into account by using a generalization of the Buttle–Goldfarb approximation. The strong dependence of the D-state effects on the angular momentum quantum numbers of the transferred nucleon is discussed in detail. (15 figures, 1 table, 67 references) (auth)

29770 FORWARD NEUTRINO-INDUCED REACTIONS ON DOUBLY-CLOSED-SHELL NUCLEI. Cannata, F. (Scuola Normale Superiore, Pisa, Italy); Leonardi, R. Phys. Rev., C; 5: No. 4, 1189-96(Apr 1972).

Neutrino-induced nuclear reactions are studied with sum-rule techniques in the limit in which these reactions involve mainly giant-resonance excitation (i.e., at small angles). Resonant excitation is particularly important because simple shell-model and Fermi-gas calculations appear to give results which are too low relative to experiment for the differential cross section at small angles. Furthermore, in the strictly forward scattering region, an interesting interplay between nonrelativistic first-forbidden and allowed relativistic terms is found. (3 figures) (auth)

29771 NUCLEAR CHARACTERISTICS AND EMPIRICAL MASS SUM RULES. Bassichis, W. H. (Texas A and M Univ., College Station); Kelson, I. Phys. Rev., C; 5: No. 4, 1169-73(Apr 1972).

The Garvey–Kelson mass sum rule is known to be violated when Z = N = odd, Z = N + 1 = even, or Z = N + 1 = odd nuclei are considered. This violation is a result of the lack of cancellation of certain two-body matrix elements. These matrix elements can be calculated by assuming various models of the nuclei involved, e.g., deformation, level ordering, etc., and the amount by which the sum rule is violated empirically can then be used to distinguish the most appropriate model. The results of this empirical determination of nuclear characteristics agree quite well with the results of more involved calculations and conform to the generally accepted picture of nuclei in the s–d shell. (4 figures, 1 table) (auth)

29772 ELASTIC ELECTRON SCATTERING AND SHORT-RANGE CORRELATIONS: A REPLY TO THE NOTE BY C. CIOFI DEGLI ATTI. Fink, M.; Hebach, H.; Kuemmel, H. (Ruhr-Univ., Bochum, Ger.). Phys. Rev., C; 5: No. 4, 1434-5(Apr 1972).

1p1h amplitudes—usually large—were taken into account in the authors' previous paper. They vanish for self-consistent single-particle states and thus do not represent short-range correlations if the latter are defined as deviations from the self-consistent single-particle determinant. (auth)

29773 COULOMB EFFECTS IN THE FINAL STATE FOR THREE-BODY REACTIONS. Thompson, D. T.; Tripard, G. E.; Ehlers, D. H. (Washington State Univ., Pullman). Phys. Rev., C; 5: No. 4, 1174-80(Apr 1972).

A semiclassical Monte Carlo calculation was performed which indicates that Coulomb forces among the final-state particles may significantly affect the angular distributions and directional-correlation functions for sequential reactions with three bodies in the final state. (6 figures) (auth)

29774 OFF-SHELL TWO-BODY t MATRIX IN THE NUCLEON–NUCLEUS OPTICAL POTENTIAL. Adelberg, M. L.; Saperstein, A. M. (Wayne State Univ., Detroit). Phys. Rev., C; 5: No. 4, 1180-8(Apr 1972).

The effects of taking the two-nucleon scattering matrices off energy shell in the first term of the nucleon–nucleus optical potential are investigated. In order to avoid Coulomb interference, only neutron–nucleus elastic scattering is considered. Both the possibility of improving the fit to the elastic nucleon–nucleus scattering observables by varying off-shell parametrization and the possibility of extracting off-shell information on the nucleon–nucleon force are considered. (2 figures, 2 tables) (auth)

29775 DESCRIPTION OF ^{4}He(d,d)^{4}He POLARIZATION-TRANSFER EXPERIMENTS. Ohlsen, Gerald G.; Gammel, J. L.; Keaton, P. W. Jr. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 5: No. 4, 1205-22(Apr 1972).

A convenient parametrization of experiments in which a polarized spin-1 particle bombards a target and a polarized spin-1 particle emerges is given. The parameters defined are a generalization of the "Wolfenstein parameters" long used in the description of spin-½ polarization-transfer experiments. A specific M matrix for a spin-0 target is used to find the relations between the various observables in several coordinate systems. The formalism is valid for the general 1 + 0 → 1′ + 0′ problem, where 1 and 1′ may indicate different spin-1 particles and 0 and 0′ may indicate different spin-0 particles, but where the product of initial and final channel parities is unchanged. The constraints imposed by time-reversal invariance when the reaction is specialized to elastic scattering are discussed. The prospects for a complete determination of the M matrix and for possible time-reversal tests are briefly touched upon. (3 figures, 3 tables) (auth)

29776 SPONTANEOUS-FISSION-ISOMER EXCITATION ENERGIES FROM THRESHOLD MEASUREMENTS. Vandenbosch, R. (Univ. of Washington, Seattle). Phys. Rev., C; 5: No. 4, 1428-32(Apr 1972).

A modification to an evaporation model employed in the analysis of isomer excitation functions is presented. Isomer excitation energies deduced from the modified model are shown to be in quantitative agreement with those obtained from a more sophisticated analysis. (3 figures) (auth)

29777 STATISTICAL PROPERTIES OF NUCLEI. Proceedings of the International Conference Held at Albany, New York, August 23–27, 1971. Garg, J. B. (ed.). New York; Plenum Publishing Corporation (1972). 689p. $37.50 (CONF-710814).

Separate abstracts were prepared for the 47 invited papers included. (J.W.R.)

For abstracts of individual papers see: 29532, 29533, 29559, 29560, 29594–29598, 29622–29625, 29654, 29677–29679, 29695–29698, and 29778–29803.

29778 INTRODUCTORY TALK. Wigner, E. (Princeton Univ., N. J.). pp 7-23 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The indefiniteness of the boundaries of the subject of nuclear statistical properties is pointed out. The ensembles of Hamiltonians of statistical theory are briefly reviewed. A brief comparison of statistical theories with experiment is given. The problem of Hamiltonian or collision matrix is examined. (J.W.R.)

29779 SURVEY OF RESONANCE REACTION THEORIES. Feshbach, H. (Massachusetts Inst. of Tech., Cambridge). pp 25-44 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The various formalisms for studying resonances in nuclear reactions are reviewed. The similarities between the formalisms are emphasized. Methods for the extraction of resonance parameters are discussed. The physical interpretation of the resonance parameters is examined in detail. (J.W.R.)

29780 UNITARY PARAMETRIZATION OF NUCLEAR REACTIONS. Humblet, J.; Lejeune, A.; Nagarajan, M. A. (Univ., Liege). pp 45-51 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The unitarity of approximate collision matrices derived from any few-level approximation of a modified k matrix is pointed out. The k-matrix parametrization of nuclear reactions is discussed. The one-channel case is examined in detail. (J.W.R.)

29781 HIGH RESOLUTION NEUTRON CROSS SECTIONS. Moore, M. S. (Los Alamos Scientific Lab., N. Mex.). pp 55-79 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

Current techniques in the measurement and analysis of high resolution neutron cross sections are reviewed. In the energy region in which the resonance structure is resolved, only for fissile target nuclei is the present situation unsatisfactory. This is attributed to insufficient data, particularly with respect to resonance spins. Fission fragment anisotropies are found to be correlated both with fission widths of the resonances and with the fission mass distribution, and such measurements are expected to be fundamental to resonance analysis. In the unresolved resonance region, the fissionable targets still are a major problem because of intermediate structure in fission. While a systematic approach to the problem is still lacking, the use of a runs statistic (following a suggestion by G. D. James) seems to hold promise. (auth)

29782 COMPARISON OF FESHBACH AND R-MATRIX REACTION THEORIES FOR $^{12}C(n,n)^{12}C$. Robson, B. A.; Van Megen, W. J. (Australian National Univ., Canberra). pp 91-7 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

Neutron elastic scattering by ^{12}C below the inelastic threshold at 4.43 MeV was analyzed by the Feshbach and R-matrix theories. The positive parity states of the ^{13}C system were described by both a shell model and a collective model. It was found that contributions from higher levels needed to be ignored in the Feshbach analysis. Both methods gave a satisfactory description of some differential cross section and polarization data below 3 MeV. (J.W.R.)

29783 FLUCTUATIONS IN CHARGED PARTICLE CROSS SECTIONS. Gibbs, W. R. (Los Alamos Scientific Lab., N. Mex.). pp 131-8 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The theory of random fluctuations in charged particle cross sections as a function of energy which was developed by Ericson is discussed. The experimental work performed to test the statistical model of these fluctuations is briefly reviewed. (J.W.R.)

29784 COHERENCE WIDTHS IN HIGHLY EXCITED COMPOUND NUCLEI. Eberhard, K. A.; Richter, A. (Univ., Munich. Ruhr Univ., Bochum, Ger.). pp 139-48 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

A statistical model with various approximations has been used to calculate the mean level widths as a function of energy and angular momentum of compound nuclei excited in the continuum region. The results are compared with all experimentally determined coherence widths available between mass numbers A = 16 and A = 116. Furthermore, for some nuclei the ratio of the mean level width to the mean level spacing, which is useful in Hauser–Feshbach calculations, is also calculated and compared with experiment. (auth)

29785 DISTRIBUTION OF NEUTRON AND FISSION WIDTHS. Michaudon, A. (CEN de Saclay, Gif-sur-Yvette, France). pp 149-77 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The Porter–Thomas statistical description of the distribution of reactions widths for compound nuclei is reviewed. This statistical approach is used as the starting point for the analysis of the available data on neutron and fission widths. It is also shown that the distributions of these widths cannot all be explained unless sophisticated additions to the theory are made. (J.W.R.)

29786 LEVEL SPACINGS, CORRELATION FUNCTIONS AND STATISTICS. Mehta, M. L. (CEN de Saclay, Gif-sur-Yvette, France). pp 179-94 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The theory of random matrices for calculating nuclear level spacings is reviewed. The question of finding suitable statistics for comparing experimental data with theory is discussed. Some of the analytical successes are described. Some of the shortcomings are also discussed. (J.W.R.)

29787 SOME PROPERTIES OF LEVEL SPACING DISTRIBUTIONS. Bohigas, O. (Institut de Physique Nucleaire, Orsay, France); Flores, J. pp 195-204 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

Some local properties of spectra calculated by ensembles of random matrices are discussed. Level spacing distributions derived using two-body random ensembles and Gaussian orthogonal ensembles are compared. A Monte Carlo calculation of properties of Gaussian orthogonal ensembles is discussed. The theoretical prediction on spacing distributions are compared with experimental results. (J.W.R.)

29788 RECENT EXPERIMENTAL NEUTRON RESONANCE SPECTROSCOPY RESULTS AS A TEST OF STATISTICAL THEORIES OF SHORT AND LONG RANGE ORDER FOR LEVEL SPACING. Camarda, H. (Columbia Univ., New York); Liou, H. I.; Rahn, F.; (and others). pp 205-13 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

Neutron resonance spectroscopy data for even-even nuclei in the A = 150 to 190 range were analyzed with various statistical methods. Some of the results are discussed. (J.W.R.)

29789 DEVIATIONS FROM THE STATISTICAL DESCRIPTION OF NEUTRON LEVEL SPACING DISTRIBUTIONS AND STABILIZING EFFECTS OF NUCLEAR SHELLS IN POSITIONS

OF NUCLEAR EXCITED STATES. Sukhoruchkin, S. I. (Inst. of Theoretical and Experimental Physics, Moscow). pp 215-29 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

Some of the nonstatistical effects encountered in resonance neutron spectroscopy are reviewed. The topics discussed include the hyperfine structure of energy splittings, the fine structure of nuclear levels, the stabilizing effect of nuclear shells, correlations in binding energies of light nuclei, and the particle mass spectrum analysis. (J.W.R.)

29790 MEASUREMENT OF RADIATIVE CAPTURE WIDTHS. Chrien, R. E. (Brookhaven National Lab., Upton, N. Y.). pp 233-42 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The use of resonance neutron capture spectroscopy in studies of highly excited states near the neutron separation energy is discussed. The statistical analysis of radiative widths determined by resonance capture γ spectroscopy is discussed. Some recent experiments are surveyed as examples. (J.W.R.)

29791 CORRELATIONS BETWEEN PARTIAL WIDTHS OF DIFFERENT CHANNELS. Lane, Anthony M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 271-89 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The correlations which have been observed between partial widths for different reaction channels are examined. The theoretical background is sketched, and the experimental data are reviewed. The current state of theoretical understanding is discussed. (J.W.R.)

29792 SEARCH OF NON-STATISTICAL EFFECTS IN NEUTRON CAPTURE. Mughabghab, Said F. (Brookhaven National Lab., Upton, N. Y.). pp 291-8 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The nonstatistical effects generated by the occurrence of doorway states in neutron capture are discussed. The application of the valence neutron model to such processes is examined. (J.W.R.)

29793 STRENGTH FUNCTIONS AND INTERMEDIATE STRUCTURE. Newson, Henry W. (Triangle Universities Nuclear Lab., Durham, N. C. Duke Univ., Durham, N. C.). pp 309-25 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

Some recent data on neutron strength functions are reviewed. The intermediate structure seen in these data are analyzed. It is concluded that doorway states and other intermediate structure play some part in almost all neutron cross sections, but that large spreading widths cause the doorway states to overlap. As a result, except near doubly magic nuclei, it is usually impossible to separate these effects from those described by the optical model. (J.W.R.)

29794 RESONANCE PARAMETERS AND THE OPTICAL MODEL. Moldauer, P. A. (Argonne National Lab., Ill.). pp 335-50 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The role of the optical model in nuclear reaction theory is reviewed. The compound nucleus, R-matrix theory, and S-matrix poles are discussed in connection with the optical model. It is shown that the optical model, together with an appropriate resonance formalism, provides important information on average resonance parameters, average cross sections, and cross section fluctuations. (J.W.R.)

29795 S- AND P-WAVE STRENGTH FUNCTIONS AND THE SPIN, ISOSPIN, AND SPIN–ORBIT DEPENDENCE OF THE OPTICAL POTENTIAL. Newstead, C. M.; Delaroche, J.; Cauvin, B. (CEN, Saclay, France). pp 367-75 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

Some S- and P-wave neutron strength functions which appear to be spin, isospin, or spin-orbit dependent are reviewed. Implications for optical model potentials for the resonances involved are discussed. (J.W.R.)

29796 SURVEY OF NUCLEAR LEVEL DENSITY THEORIES. Bloch, Claude (CEN de Saclay, Gif-sur-Yvette, France). pp 379-403 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The general features of nuclear level density theories are discussed. Some of the various models and methods used in level density calculations are surveyed. The theory for level densities in highly deformed nuclei is examined. (J.W.R.)

29797 DISTRIBUTION THEORY OF NUCLEAR LEVEL DENSITIES AND RELATED QUANTITIES. French, J. B.; Chang, F. S. (Univ. of Rochester, N. Y.). pp 405-24 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The advantages for combining nuclear level density studies with studies of ground-state properties are discussed. The use of the central limit theorem for making the connection between the two domains is discussed. Some illustrations and applications are presented. (J.W.R.)

29798 EXPERIMENTAL AND THEORETICAL NUCLEAR LEVEL DENSITIES. Huizenga, John R. (Univ. of Rochester, N. Y.). pp 425-45 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The experimental aspects of nuclear level densities are discussed. The various methods and techniques employed in the determination of level densities are evaluated. Analyses in terms of conventional level density formulas are described. Experimental and theoretical results are reviewed and compared. (92 references) (J.W.R.)

29799 EVAPORATION SPECTRA. Halpern, I. (Univ. of Washington, Seattle). pp 465-81 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

Some problems in the analysis of evaporation spectra are described. The advantages of studying charged particle spectra from highly-excited heavy nuclei are illustrated. Evaporation spectra at lower excitations are also discussed. The relation of the inverse cross section to evaporation spectra is explained. Angular momentum effects are analyzed. The direct reaction component in reaction spectra is evaluated. (J.W.R.)

29800 ROLE OF ANGULAR MOMENTUM AND ISOBARIC SPIN IN TESTS OF THE INDEPENDENCE HYPOTHESIS. Miller, J. M. (Columbia Univ., New York). pp 505-25 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The validity of the compound-nucleus model for the description of reactions leading to residual nuclei excited into the continuum is analyzed. The topics discussed include statistical-model calculations, the independence hypothesis, the role of angular-momentum conservation, and the role of isobaric spin conservation. (J.W.R.)

29801 INTERMEDIATE STRUCTURE. Mahaux, C. (Univ., Liege). pp 545-62 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The doorway-state interpretation of intermediate structure seen in nuclear cross sections is reviewed. Experimental tests of doorway state phenomena are discussed and some data is surveyed. Some conclusions regarding the applicability of the doorway-state model are presented. (52 references) (J.W.R.)

29802 INTERMEDIATE STRUCTURE IN PHOTON INDUCED REACTIONS. Fallieros, S. (Brown Univ., Providence). pp 589-600 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The sequence of events that follow the absorption of the photon

by a nucleus are discussed. The distribution of the absorption strength as a function of the excitation energy and the dependence of the strength, total or localized, on the particle number of the nuclear system are examined. Some features of the transition densities, the functions whose moments determine the intensity of a radiative transition, will also be considered. (auth)

29803 THRESHOLD PHOTONEUTRONS AND PHOTON DOORWAYS. Berman, B. L.; Bowman, C. D.; Baglan, R. J. (Univ. of California, Berkeley). pp 611-17 of Statistical Properties of Nuclei. /Garg, J. B. (ed.). New York; Plenum Publishing Corp. (1972).

From International conference on statistical properties of nuclei; Albany, N. Y. (23 Aug 1971).

The threshold photoneutron technique for studying the properties of nuclear states is described. The type of information which can be learned from such studies is discussed. Some experimental data are reviewed as examples. (J.W.R.)

29804 CALCULATIONS OF NUCLEAR STRUCTURE. Elliott, J. P. (Univ. of Sussex, Brighton, Eng.). Proc. Roy Soc. (London), Ser. A; 326: No. 1565, 199-213(11 Jan 1972).

The field theory of elementary particles has so far failed to predict the detailed form of the interaction between neutrons and protons (nucleons), but the nucleon–nucleon scattering experiments are now sufficiently complete that for most purposes the interaction may be taken as known. At the same time a wealth of data concerning energy levels, transition probabilities, and so on is available for literally hundreds of nuclei. Such measurements reveal that nuclei have an extremely rich structure, with both single-particle and collective properties, illustrating almost every feature of a many-body system. The extent to which one is able to understand these properties on the basis of the known two-body interaction is reviewed. It is shown how some features may be understood quite readily while others still pose fascinating problems. (auth)

29805 PRE-EQUILIBRIUM DECAY AT MODERATE EXCITATIONS AND THE HYBRID MODEL. Blann, M.; Mignerey, A. (Univ. of Rochester, N. Y.). Nucl. Phys.; A186: No. 2, 245-56 (1972).

The hybrid model for pre-equilibrium decay is used in the analyses of spectra from a survey of ^{4}He and proton induced reactions at moderate energies. Results are excellent for ^{4}He induced reactions and poor for proton-induced reactions. Possible interpretations of these observations are offered. The variation of the fraction of pre-equilibrium emission predicted by the hybrid model is given as a function of mass number, particle-hole number and excitation energy. Formulas are given for calculating intermediate state lifetimes and equilibration times within the model, and this result is compared with that of the exciton model. (auth)

29806 STUDY OF RPA CORRELATIONS IN THE INTRINSIC STATE USING AN EXACTLY SOLVABLE MODEL. Ullah, N.; Gupta, K. K. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys.; A186: No. 2, 331-43(1972).

The exactly solvable model of Lipkin, Meshkov, and Glick is used to check the validity of the projected states from a deformed RPA correlated intrinsic state. Using a property of Lie algebra, the matrix element of a general quasiangular momentum operator between two RPA correlated states is worked out. The energies of the ground and excited states, the number of particles in the upper level and the transition probabilities are plotted for various values of the strength of the interaction. Comparison with projected Hartree–Fock results shows that RPA correlations in an intrinsic Hartree–Fock state result in considerable improvement, particularly near the point where the RPA solution becomes imaginary. It is shown that the quasiboson approximation overestimates RPA correlations. A new expression is derived for the correlation coefficient in Sanderson's state, which does not use the quasiboson approximation. (auth)

29807 CORRELATION OF THE MOST PROBABLE KINETIC ENERGY OF FISSION FRAGMENTS AND $\bar{\nu}_p$. Tu, Ping-shiu; Prince, A. (National Neutron Cross Section Center, Upton, N. Y.). J. Nucl. Energy; 25: No. 12, 599-614 (Dec 1971).

Correlation of the most probable kinetic energy $\langle E_k \rangle$ of fission fragments and the Coulomb energy $Z^2/A^{\frac{1}{3}}$ is presented. Further correlation of $\bar{\nu}_p$, the average number of prompt neutrons emitted per fission, vs $\langle E_k \rangle$ and $Z^2/A^{\frac{1}{3}}$, respectively, is also established. For comparative study, a new parameter $Z^2\sqrt{A}$, as suggested by Okolovich et al. (1963), is employed for correlating $\langle E_k \rangle$ and $\bar{\nu}_p$. It is found that this parameter $Z^2\sqrt{A}$ gives better consistency, when compared with experimental values of $\langle E_k \rangle$ and $\bar{\nu}_p$, for each family of isotopes in the present study by considering the logarithmic derivative $1/\langle E_k \rangle d\langle E_k \rangle/dA$. Six sets of semi-empirical polynomial equations are derived for the correlation. The data for both $\langle E_k \rangle$ and $\bar{\nu}_p$ are based on the most recent experimental investigations in this field. The formulae presented may be utilized to predict the values of $\bar{\nu}_p$ for the new isotopes produced in nuclear reactors with emphasis on the heavy nuclides that have no experimental data available. The range of atomic mass numbers under study is 228–256. (auth)

29808 QUARTET STATES AND ALPHA-PARTICLE TRANSFER. Robson, D. Comments Nucl. Particle Phys.; 5: No. 1, 16-19(Jan-Feb 1972).

The existence of "quartet states" was predicted by Gillet and Jaffrin at Saclay, who postulated that nuclei with spherical ground states would have low-lying deformed excited states, some of which would involve four particles in the same deformed orbit and should look like quasi-α-particle clusters. Such quartets could only be seen by α transfer reactions and were expected to occur at 5 to 10 MeV excitation energy in the residual nucleus. Interpretation of the Saclay data in terms of quartet structure may possibly be incorrect and alternative experiments that would clarify the role of quartet states in medium weight nuclei are suggested. The validity of a quartet state interpretation of the Saclay data depends on the assumption that the (^{16}O,^{12}C) reaction for adding an α particle to a nucleus proceeds via an α transfer mechanism, and it is important to know how well ^{16}O can fractionate into ^{12}C plus an α particle. It is considered that a more satisfactory explanation appears to be that the (^{16}O,^{12}C) reaction proceeds by mechanisms other than α transfer, and one possibility is that the reaction proceeds via compound nucleus formation. Reactions for studies of α transfer are discussed. It was concluded that there is neither adequate experimental evidence nor strong theoretical reasons for believing that quartet states exist as prominent structures in medium weight nuclei. 6 references. (UK)

29809 KAONIC ATOMS AND NUCLEAR DENSITY DISTRIBUTIONS. Henley, E. M. (Univ. of Washington, Seattle); Alberg, M.; Wilets, L. Comments Nucl. Particle Phys.; 5: No. 1, 1-5 (Jan-Feb 1972).

Studies of pionic atoms have provided some information on both proton and neutron distributions. The lifetime of a negative kaon is long compared to the time for capture into atomic orbits. The kaons spiral through the electronic cloud, losing energy by Auger transitions, and then cascade through Bohr orbits, primarily by x-ray emission, until captured by the nucleus. Capture mechanisms are discussed. Muonic x-rays and electron scattering experiments not only give a measure of the charge (proton) distribution, but also provide a probe of the neutron distribution. Reasons for differences in nuclear density distributions deduced by various authors are discussed, together with questions that remain in all of the theoretical analyses. For most nuclei agreement with the data can be obtained with traditional models, but there are certain nuclei, such as U and Pb, for which the measured capture rates are more than an order of magnitude larger than calculated values. Experimental investigations of capture products should help in a reliable theoretical understanding of absorption mechanisms in nuclei, even though secondary absorptions and other nuclear reactions can occur to distort the observations. While the theoretical uncertainties are in process of further study, experimental progress continues, particularly at CERN. 11 references. (UK)

29810 DEEPLY BOUND NEUTRON HOLE STATES STUDIED BY (p,d) REACTIONS. Sakai, Mitsuo; Kubo, Ken-ichi (Tokyo Univ.). Nucl. Phys.; A185: No. 1, 217-28(1972).

The (p,d) reaction was found to be a good tool for the investigation of deeply bound neutron hole states. The continuous part always observed in the spectrum of the (p,d) reaction was studied in detail: it was revealed that it has a gross structure and that its angular distribution is consistent with the model which predicts that the orbits deeply bound inside of the core are split into many states by the interaction with the 2h-1p configuration, to an extent that the line spectrum is smeared out due to the finite resolution of the particle spectrometer. A simple theory was presented to calculate the width of the splitting. The result is compatible with the experimental width. (auth)

29811 STATISTICAL DESCRIPTION OF A PAIRED NUCLEUS WITH THE INCLUSION OF ANGULAR MOMENTUM. Moretto, L. G. (Univ. of California, Berkeley). Nucl. Phys.; A185: No. 1, 145-65(1972).

The effect of angular momentum on an excited paired nucleus has been studied. The BCS Hamiltonian, modified to include the z-projection of angular momentum has been diagonalized and expressed in terms of the quasiparticle occupation numbers. The grand partition function and all the relevant thermodynamical functions as well as the level-density expression have been derived for the general case of an arbitrary set of single-particle

levels. Furthermore, the formalism has been applied to the uniform model and, whenever possible, analytical expressions have been derived. In particular the zero-temperature angular momentum dependence of the gap parameter, the critical angular momentum as well as the yrast line have been calculated. The critical temperature as a function of angular momentum, which defines the phase transition between paired and unpaired systems, has been calculated. A new effect called the thermally assisted pairing correlation, involving an increase of pairing with increasing temperature, has been predicted. The completeness of the formalism as applied to spherical or deformed nuclei has been discussed. (auth)

29812 RELATIVISTIC EIKONAL APPROXIMATION AND LOW-ENERGY NUCLEON–NUCLEON SCATTERING. Woloshyn, R. M.; Jackson, A. D. (State Univ. of New York, Stony Brook). Nucl. Phys.; A185: No. 1, 131-44(1972).

The need for proper asymptotic behavior of the Born amplitudes defining a nonrelativistic potential is outlined. The relativistic eikonal approximation is reviewed, and a generalized Born amplitude with contributions from crossed ladder diagrams as well as vertex corrections is constructed in the eikonal approximation. The connection between strong and electromagnetic interactions obtained through the eikonal approximation is used to constrain the parameters of nucleon-nucleon scattering. Phase shifts calculated with the generalized Born amplitude as the potential are compared with phase shifts calculated with a one-boson-exchange potential employing a phenomenological form factor. (auth)

29813 STUDIES IN THE NUCLEAR CLUSTER MODEL. III. THE k-CLUSTER CONFIGURATION. Kramer, P.; Seligman, T. H. (Univ., Tuebingen, Ger.). Nucl. Phys.; A186: No. 1, 49-64(1972).

Configurations of k clusters are adapted to orbital symmetry. Matrix elements between these states for normalization, one- and two-body operators are written as linear combinations of exchange integrals. The exchange integrals and their coefficients are classified in terms of double cosets. These double cosets and their generators are fully analyzed and their matrix elements calculated. (auth)

29814 NEUTRON ABUNDANCE IN LIGHT ELEMENT SYNTHESIS. Baumann, Germain (Univ., Nancy). Compt. Rend., Ser. B; 273: No. 23, 1047-50(8 Dec 1971). (In French).

The effect of the electron-neutrino cross section on neutron abundance in the vicinity of $T = 10^{9}$°K was studied. (France)

29815 CRYSTALLIZATION OF NEUTRONIC MATTER. Clark, J. W.; Chao, N.-C. (Abo Akademi, Finland). Nature (London) Phys. Sci.; 236: No. 64, 37-9(20 Mar 1972).

The solidification pressure P_s of neutron matter was estimated on the basis of the quantum mechanical principle of corresponding states, using density-dependent characteristic reduction parameters derived from a realistic two-nucleon interaction. Three procedures yield $P_s \approx 5 \times 10^{27}$ atm, in essential agreement with an earlier estimate. (auth)

29816 SINGLE-PHONON STATE OF EVEN–EVEN NUCLEI AND NONROTATIONAL STATES OF A SERIES OF ODD NUCLEI IN THE ACTINIDE REGION. Komov, A. L.; Malov, L. A.; Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 8, 1550-61(Aug 1971). (In Russian).

The energies and wave functions of single-phonon quadrupole octupole states of even-even nuclei were calculated in the region $234 \leq A \leq 250$, with the corresponding B(E2)- and B(E3)-values. The energies and wave functions of nonrotational states of a number of odd nuclei were computed. Energy values and structure of the ground and excited states are tabulated for the following isotopes: ^{237}Pu, ^{243}Pu, ^{243}Cm, ^{235}Np, ^{239}Np, ^{243}Am, ^{245}Am, and ^{247}Bk. (K.S.W.)

29817 ROLE OF THE DISPERSION EFFECT IN THE METHOD OF CORRELATED BASIS FUNCTIONS. Ristig, M. L. (Univ., Cologne); Clark, J. W. Phys. Rev., C; 5: No. 4, 1233-7(Apr 1972).

A consistent procedure is developed for introducing an external single-particle potential into the cluster expansion of the energy expectation value with respect to a correlated wave function. It is shown that the usual Brueckner reaction-matrix approximation may be extracted from the correlated-basis-functions theory by a special treatment of the external potential and an associated special choice of two-body correlation factor. (auth)

29818 RELATIONSHIP BETWEEN THE TRANSITION MOMENTS OF INERTIA AND THE INTRINSIC TRANSITION QUADRUPOLE MOMENTS. Mantri, A. N.; Sood, P. C. (Banaras Hindu Univ., India). Phys. Rev., C; 5: No. 4, 1422-5(Apr 1972).

In the "variable-moment-of-inertia" model an empirical relation was established between the transition quadrupole moments and the transition moments of inertia for the levels of ground-state bands in even–even nuclei. Later, a modification was proposed in the form of introducing an explicit A^{λ} dependence in this relation, and also an alternative expression for the definition of the transition moment of inertia was adopted. These modifications are examined in comparison with the original assumptions through detailed analysis of the experimental data. No significant improvement in the fit to the data is observed as a result of the modified formulation. (1 figure, 2 tables) (auth)

29819 INCLUSION OF FISSION AND CHARGED-PARTICLE EMISSION IN CALCULATIONS OF NUCLEAR REACTIONS. Hahn, R. L. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A185: No. 1, 241-51(1972).

The inclusion of the competition between particle emission and fission in existing intranuclear cascade calculations is discussed It is demonstrated that the cross section for the evaporation from compound-nucleus c of any particles x, be they neutrons or charged particles, can be expressed as $\sigma(c,x,f) = \sigma_c P_x \Pi_{i=1}^{x} [\Gamma_n/(\Gamma_n + \Gamma_f)]_i$. Here σ_c is the compound-nucleus formation cross section, P_x is the usual probability of emission of the x particles in the absence of fission, and the factor in brackets considers the competition between fission and particle emission at each step in the evaporation chain. This result is to be contrasted with most earlier treatments that assumed $P_x = 0$ unless all of the emitted particles i were neutrons. The empirical formula of Sikkeland et al., with its simple dependence upon atomic number Z and neutron number N for heavy-element nuclei, is shown to be an appropriate measure of $[\Gamma_n/(\Gamma_n + \Gamma_f)]_i$ in cases where charged particles as well as neutrons compete with the fission process. Excitation functions were calculated for reactions of ^{231}Pa with ≲65 MeV protons and are presented in this paper to illustrate effects due to the inclusion of charged-particle evaporation and fission-spallation competition. (auth)

29820 K-MATRIX THEORY OF THREE-BODY PROBLEMS. Sasakawa, T. (Tohoku Univ., Sendai). Nucl. Phys.; A186: No. 2, 417-37(1972).

The two-body Green function in the three-body system is decomposed into open channels and closed channels. The three-body wave function is decomposed in a manner that the scattering amplitudes satisfy the reciprocity relations. On the basis of this wave function, the relations between the S-, T- and K-matrices are obtained just in the same form as in the two-body problem. The integral kernel of these matrices do not contain any δ-function-type divergence. The eigenstates of the closed three-body channels are the bound states if the total energy of the system is negative. Below the threshold of the break-up channel, the three-body bound state appears as a sharp resonance if the closed channels are coupled to the open channel. The eigenstate above the threshold of the break-up channel is the three-body resonance. The relation between the two-body bound state and the three-body bound state is discussed for a simple example. The existence of the three-body resonance above the threshold of the break-up channel is demonstrated also for a simple example. The Breit–Wigner formula is derived in a unified way for below and above the threshold of the break-up channel. (auth)

29821 EFFECTS OF THE SCHEMATIC APPROXIMATION IN THE MICROSCOPIC DESCRIPTION OF COLLECTIVE NUCLEAR STATES. Hernandez, E. S. (Univ., Buenos Aires); Plastino, A. Nucl. Phys.; A186: No. 2, 297-306(1972).

A study is made concerning the effects induced by applying the schematic model, within the framework of the quasiparticle random phase approximation, to the description of collective vibrational states in deformed heavy nuclei. A very simple interaction is introduced which allows one to analyze these effects independently of the particle basis involved. It is shown that schematicity results in a great enhancement of collective transition rates, but that the energetic trend in the rare-earth and transuranic regions is not appreciably affected. (auth)

29822 AUTO-IONIZATION IN β-DECAY: A MODEL CALCULATION. Law, J.; Campbell, J. L. (Univ. of Guelph, Ont.). Nucl. Phys.; A185: No. 2, 529-43(1972).

A new theoretical treatment of auto-ionization in β-decay is presented; a one-step model is assumed and explicit account is taken of the indistinguishability of the two continuum negatons. A critical review of experimental data for the K shell is given. While agreement between recent experiments and the theory is encouraging, it is clear that new experimental data are urgently required. (auth)

29823 ESTIMATION OF E1 STRENGTH FUNCTIONS BY DIRECT REACTION INELASTIC SCATTERING. Balasubra-

manian, R.; Cohen, B. L.; Rao, G. R.; Fink, C. L.; Degnan, J. H. (Univ. of Pittsburgh). Nucl. Phys.; A185: No. 2, 488-96(1972).

A method is suggested for determining the distribution of El transition strengths from the ground state to excited states as a function of excitation energy and l; it uses direct reaction inelastic scattering and a simplifying assumption which is tested and found to be reasonably accurate. The method depends on the reliability of DWBA calculations, and experimental tests of this reliability are devised and carried out; most of these tests are failed, so results on El strength functions must await improvements in DWBA calculations. (auth)

29824 APPROXIMATE TREATMENT OF CORRELATIONS IN NUCLEAR SPECTROSCOPY. II. TWO-NUCLEON TRANSFER IN THE LEAD REGION. Vary, J. (Yale Univ., New Haven. Massachusetts Inst. of Tech., Cambridge); Ascuitto, R. J.; Ginocchio, J. N. Contract AT(30-1)-3223. Nucl. Phys.; A185: No. 2, 349-65(1972).

The effect of ground state correlations on calculated two-nucleon transfer cross sections for the reactions (p,t), (t,p), (^{3}He,p) and (^{3}He,n) in the lead region is investigated. The sensitivity to ground state correlations is isolated by comparing calculated DWBA cross sections obtained by using two-nucleon shell-model (2n SM) states with those obtained by using two-nucleon random-phase approximation (2n RPA) state descriptions. The correlations obtained in a 2n RPA calculation produce strong enhancements of the calculated ground state to ground state transitions involving the transfer of two identical particles over the same transitions calculated without correlations. In addition, certain other transitions are substantially affected while others are unaltered. The sensitivity of the calculated cross sections to the model and the choice of effective interaction is investigated and compared with the sensitivity of other calculated quantities. (auth)

29825 BOSON METHOD NOT VIOLATING THE PAULI PRINCIPLE APPLIED TO THE THREE-QUASIPARTICLE SYSTEM. Simard, P. A.; Banville, M. (Univ. of Sherbrooke, Quebec). Can. J. Phys.; 49: No. 24, 3122-32(15 Dec 1971).

The boson method is studied for a system with one and three quasiparticles. A basis is constructed in the ideal space in such a way that the Pauli principle is fully satisfied. The spurious states due to the particle nonconservation are properly eliminated. Numerical calculations are presented and a comparison is made with Kuo's method. The boson method can be easily extended to the study of systems having two phonons. (auth)

29826 SPIN–ORBIT FORCE AND EXCITATION OF UNNATURAL-PARITY STATES BY α-PARTICLES. Boridy, Elie; Pearson, J. M. (Univ. of Montreal). Nucl. Phys.; A185: No. 2, 593-600 (1972).

Satchler's microscopic formulation of the DWBA for inelastic scattering is extended to include a vector, i.e., two-body spin-orbit force. In this way the data of Harvey et al. on the excitation of the 8.87 MeV 2^- level in ^{16}O by 40.5 α-particles are analyzed. The integrated cross section decreases with increasing energy in this region, contrary to earlier qualitative predictions. (auth)

29827 HELICITY REPRESENTATION OF THE N–N BOUND-STATE PROBLEM. Alzetta, R.; Erkelenz, K.; Holinde, K. (Univ., Bonn). Nucl. Phys.; A185: No. 2, 459-64(1972).

The two-nucleon bound-state problem described in the momentum space is presented in the helicity state formalism. (auth)

29828 M1 TRANSITIONS AND THE VALIDITY OF SU(4) SYMMETRY IN LIGHT NUCLEI. Nang, Pham Tri (Scuola Normale Superiore, Pisa, Italy. Ecole Polytechnique, Paris). Nucl. Phys.; A185: No. 2, 413-32(1972).

A sum rule for M1 transitions is derived and is found to be saturated with low-lying states in ^{6}Li and ^{10}B. This is consistent with a very small amount of supermultiplet impurity present in the ground state. For self-conjugate 4N and conjugate 4N ± 1 nuclei, using experimental data on $\Delta T = 1$ M1 transitions from the ground to excited states, it is possible to estimate the supermultiplet impurity present in the ground state. It is found that the amount of supermultiplet impurity reaches a maximum at the middle of the shell and decreases to zero at the beginning and at the end of the shell. Under the assumption that the giant magnetic dipole resonance dominates the sum rules a relation was found which predicts the excitation energy of the $T = 0$, $J^\pi = 1^+$ state in ^{12}C to be 12 MeV as compared with the experimental value of 12.71 MeV. (auth)

29829 THEORETICAL STUDY OF ^{6}Li INDUCED REACTIONS: A THREE-BODY PROBLEM APPROACH. Osman, Ahmed (Cairo Univ.). Particles Nucl.; 3: No. 1, 28-39(Jan 1972).

A soluble three-body model for ^{6}Li-induced reactions is presented. The ^{6}Li nucleus is viewed as a deuteron + alpha cluster structure. A simple two-particle interaction with separable potentials is introduced. These potentials reduce the three-body problem to the solution of coupled sets of one-dimensional Fredholm integral equations. The angular distributions for ^{6}Li stripping and elastic scattering on a target nucleus X are calculated. Good agreement with the experimental measurements is obtained. (14 figures) (auth)

29830 EFFECTIVE INTERACTION IN α-NUCLEUS SCATTERING. Mailandt, P.; Lilley, J. S.; Greenless, G. W. (Univ. of Minnesota, Minneapolis). Phys. Rev. Lett.; 28: No. 16, 1075-7(17 Apr 1972).

Elastic α-nucleus differential cross-section data (15°–175°) are analyzed using a potential model. The real potential is calculated using an effective potential obtained from a global analysis of nucleon-α data. The resulting four-parameter model gives an excellent representation of the α-nucleus data. This representation is significantly better than can be obtained with a six-parameter optical model and is sensitive to the nuclear-nucleon density distribution. (auth)

29831 FUNNY HILLS: THE SHELL-CORRECTION APPROACH TO NUCLEAR SHELL EFFECTS AND ITS APPLICATIONS TO THE FISSION PROCESS. Brack, M.; Damgaard, Jens; Jensen, A. S.; Pauli, H. C.; Strutinskii, V. M.; Wong, C. Y. (Univ. of Copenhagen). Rev. Mod. Phys.; 44: No. 2, 320-406(Apr 1972).

This paper reviews various results related to the single-particle structure in spherical and deformed nuclei, discussed from the viewpoint of the so-called shell-correction method. This method stresses the importance of large-scale nonuniformities in the energy distribution of the individual particles especially near the Fermi energy. The way in which these nonuniformities affect in an essential way many nuclear properties, such as the shape stiffness, the spatial density distribution, the total mass of the nucleus, the mass and inertia of the nuclear shape variations, etc. is also discussed. Against this background, the behavior of the nuclear deformation energy is described, in particular for larger distortions relevant to the fission process. In this connection, some qualitative singularities of the phenomenological liquid-drop deformation energy at large shape distortions are pointed out, and their possible implications for fission are discussed. As the problems considered cover a wide range of nuclear properties, this paper is not a review in the narrow sense of the word. Comparison with other approaches as well as historic references are given mainly to clarify specific points, because a complete review would be a monumental undertaking. (auth)

29832 IMPORTANCE OF THE NUCLEAR DENSITY DISTRIBUTION ON PRE-EQUILIBRIUM DECAY. Blann, Marshall (Univ. of Rochester, N. Y.). Phys. Rev. Lett.; 28: No. 12, 757-9(20 Mar 1972).

A Thomas–Fermi approach is used to investigate the importance of the nuclear density distribution on pre-equilibrium decay. Two different density-dependent phenomena are pointed out, and both are shown to be equally important in modifying and improving pre-equilibrium decay predictions with respect to earlier models in which average density distributions were assumed. (auth)

29833 SPIN–SPIN TERMS IN THE NUCLEON–NUCLEUS OPTICAL POTENTIAL. Satchler, G. R. (Oak Ridge National Lab., Tenn.). Particles Nucl.; 1: No. 7, 397-411(Apr 1971).

The structure of the spin–spin interaction in the nucleon–nucleus optical potential is examined. Its strength is estimated using a single-particle model. It is shown that core polarization effects tend to reduce its strength severely. This reduction can be correlated with the shift of the nuclear magnetic moment away from the single-particle value. Contributions from the nucleon–nucleon tensor force are also considered. (1 figure) (auth)

29834 DAMPING OF DEEP SINGLE-HOLE STATES IN NUCLEI. Hughes, T. A. (IBM Scientific Center, Houston, Tex.); Fallieros, S.; Goulard, B. Particles Nucl.; 2: No. 2, 93-106 (Aug 1971).

Properties of single-hole states resulting from the elimination of a deeply bound nucleon from a nucleus are studied. The damping of these states, which reflects their coupling to more complex excitations, is calculated; and the regularities in its mass dependence are discussed. Expressions exhibiting the mass-number dependence of the level density of two-hole–one-particle excitations and of the nuclear-interaction matrix elements are also obtained. (2 figures, 1 table) (auth)

29835 NUCLEAR SCATTTERING POTENTIALS FOR COMPOSITE PROJECTILES. Ludwig, E. J.; Thompson, W. J.; Votava, H. J. (Univ. of North Carolina, Chapel Hill). Particles Nucl.; 2: No. 2, 107-12(Aug 1971).

An informal meeting was held to discuss the determination of

optical potentials for nuclear elastic scattering of projectiles of atomic mass number 2, 3, and 4. The meeting highlighted and summarized the following topics: the theoretical evaluation of the optical-model potentials derived from nuclear-scattering potentials for nucleons; the present status of phenomenological descriptions of composite-projectile scattering cross sections and spin polarization in terms of optical-model potentials; and the sensitivity to these scattering potentials of DWBA analyses of direct quasi-elastic, inelastic, and transfer reactions involving composite projectiles with $A \leq 4$. (R.W.R.)

29836 EFFECT OF THE D-STATE ON THE EFFECTIVE INTERACTION FOR (^{3}He,t) REACTIONS. Bhattacharya, M. G. (Florida Inst. of Tech., Melbourne); Pinkston, W. T. Particles Nucl.; 3: No. 1, 46-52(Jan 1972).

The effect of the D state of the 3-body system on the effective central and tensor interactions for (^{3}He,t), (^{3}He,^{3}He'), and (t,t') reactions is discussed. Calculations are made specifically for the effective interaction for (^{3}He,t). It is found that these effects are significant at short distances but are small in the region of 2 to 5 fm, which is most important in distorted-wave calculations; hence, ignoring the effect of the D state in computing the effective interaction is probably justified. (1 figure) (auth)

29837 NEAR BARRIER FISSION INDUCED WITH PHOTONS. Huizenga, John R. (Univ. of Rochester, N. Y.). Nucl. Technol.; 14: No. 1, 20-32(Apr 1972).

Theoretical expressions are developed for near barrier fission of even targets induced with dipole and quadrupole photons. Although the formulas are developed for a single-humped fission barrier and valid when the second barrier has the higher energy, the same equations are applicable for a two-humped barrier by introducing a more complicated expression for the fission transmission coefficients. Dipole fission of an odd mass target is discussed also. Some comparisons are made between theory and experiment. (auth)

29838 THEORY OF DELAYED-NEUTRON PHYSICS. Tomlinson, L. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Technol.; 14: No. 1, 42-52(Apr 1972).

At least 38 of the fission product isotopes are now known to be delayed neutron precursors. The region of delayed neutron emission for each fission product element is predicted successfully by recent mass formulas and the neutron emission probability (P_n) can be approximately related to basic nuclear parameters. Using P_n values and calculated cumulative fission yields, it is possible to account for some features of gross delayed neutron emission from various types of fission. Further significant progress in understanding delayed neutron emission is expected in the near future when spectroscopic studies are made on delayed neutron precursors. (auth)

29839 EFFECTIVE INTERACTION FOR INELASTIC DEUTERON SCATTERING. Satchler, G. R. (Oak Ridge National Lab., Tenn. Nuclear Physics Lab., Oxford). Particles Nucl.; 2: No. 3, 147-67(Sep 1971).

The effective deuteron—nucleon interaction to be used in a microscopic description of inelastic deuteron scattering is discussed. Reasonable agreement with experiment is obtained when exchange terms and a phenomenological (collective model) imaginary interaction are included. (13 figures, 1 table) (auth)

29840 SEARCH FOR NEW COUPLING SCHEMES. THE NUCLEAR f–p SHELL. Hecht, K. T. (Oak Ridge National Lab., Tenn. Univ. of Michigan, Ann Arbor). Particles Nucl.; 2: No. 3, 117-46(Sep 1971).

The failure of the SU(3) scheme to give a good description for nuclei in the f—p shell has led to a search for alternate coupling schemes. In SU(3) the single-particle state with $l = 1 + 3$ is built from three totally symmetrically coupled angular momentum objects (oscillator quanta). It is also possible to obtain this single-particle state from two antisymmetrically coupled spin-2 "objects" (leading to SU(5) and R(5)) or from two symmetrically coupled spin-$\frac{3}{2}$ "objects" (leading to SU(4) and Sp(4)), where these two schemes are related since R(5) and Sp(4) have Lie algebras of the same structure. In all, three new group chains of the type $U(10) \supset G \supset R(5) \supset R(3)$ can be considered as bases for possible classification schemes, with G = SU(5), SU(4), or R(10). The potential usefulness of these schemes is tested in terms of simple schematic models and an analysis of the wave functions of the low-lying levels for two particles. Explicit expressions are given for infinitesimal generators and Casimir operators, and branching rules are discussed. (1 figure, 9 tables) (auth)

PHYSICS (PLASMA AND THERMONUCLEAR)

29841 (NP-19225) ANNUAL REPORT, 1970. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). 263p. (In German). Dep. NTIS (U. S. Sales Only).

Reported are studies performed during 1970 at the Institute for Plasma Physics at Munich. Ten reports discuss problems such as linear theta pinch, linear screw pinch, toroidal screw pinch, and toroidal theta pinch. Twelve additional reports concern stellarator experiments and treat themes such as multipoles, microwave diagnostics and optics, and ion-temperature measurements in barium plasmas. Also reported are experiments about magneto-electric containment of high-density plasma. The chapter on MHD generators treats problems such as noble gases, plasma production through lasers, and plasma waves. Special studies are devoted to the interaction between plasma and container wall. Under relativistic plasmas, experimental studies in electron rings are reported. Theoretical investigations treat problems such as macroscopic and microscopic equilibrium and stability, turbulence, kinetic theory and interaction in plasmas, plasma simulation, and the development of computer programs. (H.B.G.)

29842 (UCRL-50002-71) CONTROLLED THERMONUCLEAR RESEARCH. Annual Report, July 1970-June 1971. (California Univ., Livermore. Lawrence Livermore Lab.). 21 Sep 1971. Contract W-7405-eng-48. 191p. Dep. NTIS.

This report describes the research and development work done at the Lawrence Livermore Laboratory and the Lawrence Berkeley Laboratory during fiscal year 1971 on the Controlled Thermonuclear Reactor program. The major divisions of the program are the magnetic mirror program (which includes the 2X, Baseball II, and direct-conversion experiments), the Astron program, the toroidal confinement program (which involves the Livermore superconducting levitron), and plasma and spectroscopic research. In addition, this report covers the extensive theoretical studies (including computer simulation) and mechanical and electronic engineering work done in these areas. The talks and publications of the CTR researchers are also listed. (auth)

29843 TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS. VOLUME 6, NO. 2, 1972. Bibliography, Author Index, Subject Index, Appendix. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 58p.

This listing contains 296 references on various aspects of the subject. (M.O.W.)

29844 CONTROLLED THERMONUCLEAR RESEARCH. PART 1. HEARINGS BEFORE THE SUBCOMMITTEE ON RESEARCH, DEVELOPMENT, AND RADIATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-SECOND CONGRESS, FIRST SESSION, ON THE CURRENT STATUS OF THE THERMONUCLEAR RESEARCH PROGRAM IN THE UNITED STATES, NOVEMBER 10 AND 11, 1971. Washington, D. C.; Joint Committee on Atomic Energy (1972). 273p. GPO $1.25.

This, Part 1 of the hearings, includes statements to and discussions with the Subcommittee by USAEC Commissioner C. E. Larson, other USAEC administrative officials, and various scientists from universities and national laboratories engaged in thermonuclear research. (M.O.W.)

29845 CONTROLLED THERMONUCLEAR RESEARCH. PART 2. HEARINGS BEFORE THE SUBCOMMITTEE ON RESEARCH, DEVELOPMENT, AND RADIATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-SECOND CONGRESS, FIRST SESSION, ON THE CURRENT STATUS OF THE THERMONUCLEAR RESEARCH PROGRAM IN THE UNITED STATES, NOVEMBER 10 AND 11, 1971. Washington, D. C.; Joint Committee on Atomic Energy (1971). 401p. GPO $1.50.

Part 2 includes a glossary of plasma physics terms and 36 appendices containing technical papers as supplementary information for the hearings presented in Part 1. (M.O.W.)

Confinement and Heating

Refer also to abstract 29659.

29846 (COO-3421-1) STEADY STATE SOLUTIONS OF AN ION INJECTION SPHERICAL ELECTROSTATIC CONFINEMENT DEVICE WITH COEXISTING BEAM AND TRAPPED PARTICLES. Hu, Kung-ming (Pennsylvania State Univ., University Park. Dept. of Nuclear Engineering). Jun 1971. Contract AT(11-1)-3421. 85p. Dep. NTIS.

Thesis.

Theoretical solutions for the potential, density, and pressure are obtained for a spherical electrostatic fusion confinement device using ion injection. The charged particles in the device are assumed to consist of monoenergetic-beam particles and distributed trapped particles, both with purely radial motions. Self-developed potential wells, as deep as the negative voltage applied to the cathode, exist for various combinations of beam particles and trapped particles. The self-developed well of primary interest contains a virtual anode (i.e., a point at which the potential equals that of the grounded anode) inside the cathode, and a virtual cathode (where the potential equals that of the real cathode) inside the virtual anode. Beam, but not trapped, particles establish these virtual electrodes. Ions can be trapped in the potential wells on either side of the virtual anode while electrons are trapped between the real cathode and the virtual cathode. The trapped-particle distributions are taken as uniform in velocity space. Various ratios of trapped-to-beam particle currents are studied to determine the effects of trapped particles on potential shape and on ion current amplification (i.e., the ratio of the ion current at the virtual cathode to the input ion current). The following effects are noted: (1) trapped electrons cause the virtual anode to move toward the center; (2) trapped ions inside the virtual anode cause the virtual cathode to move toward the center; (3) trapped ions outside the virtual anode cause the virtual anode to move outward; (4) the latter effect provides a basis for explaining a possible virtual anode found experimentally by Hirsch; and (5) current amplification is less than 1.5 if there are no trapped ions outside the virtual anode, but can be large when such ions are present. (auth)

29847 (ORNL-TM-3731) NUMERICAL CALCULATIONS OF OFF-RESONANCE HEATING. Sprott, J. C. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 22p. Dep. NTIS.

The off-resonance heating observed in hot-electron plasmas at Oak Ridge and elsewhere is explained in terms of harmonic resonances, appropriately modified to include relativistic and Doppler effects. A theoretical expression for the heating rate is proposed and is found to agree with the results of a computer simulation over a range of parameters. The theoretical heating rate is evaluated numerically for several special cases, including a uniform magnetic field, a mirror field with a 2:1 mirror ratio, and a large-aspect-ratio bumpy torus. The enhanced axial loss observed experimentally with heating below the cyclotron frequency is explained by absorption at harmonics of the electron bounce frequency. (auth)

29848 ELECTRON HEATING IN A BEAM-PLASMA DISCHARGE. Kirichenko, G. S.; Khmaruk, V. G. (Inst. for Nuclear Research, Kiev). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 10, 1646-9(Apr 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 10, 2079-83(Oct 1971).

A steady-state weakly ionized plasma ($n = 10^9$ to 10^{11} cm^{-3}, T_e = 5 to 50 eV) was studied in a uniform magnetic field into which an electron beam (I = 5 to 20 mA, U = 50 to 200 V) is injected. In this beam-plasma system, the electron temperature is determined primarily by the pressure of the neutral gas and the length of the plasma column. The range of conditions for which appreciable electron heating occurs is considerably narrower than in the case for a strong beam-plasma interaction. (auth)

29849 LASER HEATING OF PLASMA BY HEAT CONDUCTIVITY MECHANISM TAKING INTO ACCOUNT THE RECOVERY OF FUSION ENERGY. Kaliski, S. (Inst. of Fundamental Technical Problems, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 19: No. 11-12, 829-37(1971).

The problem of laser heating of plasma, based on a heat-conduction mechanism and considering the recovery of nuclear microfusion heat, is discussed. The plane problem is studied. By applying the method of momentums (quasi-averaging) with an appropriate set of approximations to the recovery curve $\Phi(T)$ (by means of central chords) the problem may be solved in quadratures, this being a quite new result. The significance of such a complex problem solved in an analytic manner seems to be essential. It is possible for parameters of the nuclear microfusion process to be optimized due to a laser impulse. The solution is valid for the initial phase of the process only, in which plasma heating by heat conduction is predominant. (auth)

29850 PLASMA CONTAINMENT DEVICE. Haeff, Andrew V. (to TRW Inc.). U. S. Patent 3,643,123. 15 Feb 1972. Filed 28 Oct 1968.

This plasma confinement device has separate means for repelling positive ions and for repelling electrons from the walls of the

plasma chamber. The electrons are repelled from the central portion of the chamber by a sufficiently strong magnetic field. However, the positive ions which are little affected by the magnetic field are repelled from the walls of the chamber by making the walls of an insulating material that charges positively by impact of a few of the positive ions. The chamber has two end portions, one of which includes an ion generator and accelerator which tends to repel electrons, the other end portion is provided with an electron repeller. On the other hand, the positive ions are kept out of the end portions of the chamber by the positive charge on the walls thereof. (auth)

29851 rf PLASMA HEATING IN A MIRROR MACHINE AT FREQUENCIES NEAR THE ION CYCLOTRON FREQUENCY AND ITS HARMONICS. Swanson, D. G. (Univ. of Texas, Austin); Clark, R. W.; Korn, P.; Robertson, S.; Wharton, C. B. Phys. Rev. Lett.; 28: No. 16, 1015-19(17 Apr 1972).

By applying 75 kW of pulsed rf power to a decaying hydrogen plasma following turbulent heating, a plasma density of 10^{12} to 5×10^{12} cm^{-3} was obtained for the 600-μ sec duration of the rf pulse. Neutral energy analyzer measurements of ion temperature indicate $T_i \sim 100$ eV, while diamagnetic loop measurements indicate 100 eV < $T_e + T_i$ < 200 eV. Probe measurements made using different equipment show discrete changes in the amplitude of the rf signals near the harmonics of the ion cyclotron frequency. (auth)

29852 EFFECT OF ROTATIONAL TRANSFORM ON TOROIDAL CONFINEMENT. Hellberg, M. A.; Winson, N. K.; Dawson, J. M. (Princeton Univ., N. J.). Phys. Rev. Lett.; 28: No. 16, 1022-5(17 Apr 1972).

A one-fluid simulation model was used to investigate diffusion in a low-β toroidal plasma. The plasma behavior exhibits two disjoint regimes as a function of rotational transform. Larger transform yields unshocked flow and effectively classical plasma loss. With a decrease of only a few percent in transform angle, an abrupt transition occurs and a standing shock appears, with an associated large increase in plasma loss. (auth)

Diagnostics

Refer also to abstract 29881.

29853 (FRNC-TH-160) RESEARCH AND DEVELOPMENT INVOLVED IN THE CONCEPTION OF A DEVICE FOR DETERMINING THE INSTANTANEOUS ELECTRON DISTRIBUTION FUNCTION IN THE PLASMA OF A POSITIVE COLUMN, WHICH IS EITHER CALM OR PERTURBED BY A PERIODIC SIGNAL. Rabache, Pierre (Paris Univ., Orsay (France)). 1971. 100p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Two methods were developed for recording the energy distribution function (EDF) in a positive column plasma. The first method utilizes an analogue differentiator and is suitable for measurements on quiescent plasmas. The second method utilizes a digital differentiator and is suitable for measurements on plasmas periodically perturbed with frequencies up to 50 kHz. The second method was applied to a quiescent plasma and the two methods were subsequently compared. It was found that, in a low current positive He discharge column, the EDF is Maxwellian when the electron energy is less than the first excitation threshold, and that above this value, a deficiency in fast electrons occurs. The properties (density, electron temperature, and plasma potential) of a positive column perturbed by a strong discharge current modulation (striations) were studied. A modification in the mean magnitudes characterizing the plasma was observed. (France)

29854 (FRNC-TH-166) PERTURBED ANGULAR CORRELATION APPLIED TO QUADRUPOLE COUPLING INVESTIGATION IN SOLIDS. Boyer, Pierre (Universite Scientifique et Medicale de Grenoble (France). Faculte des Sciences). 1971. 133p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The effect of impurities and defects on quadrupolar interaction in metallic Hf was studied. The effect of Zr on the quadrupolar interaction experienced by a Ta nucleus acting as a probe in an Hf matrix was established. Comparisons with results obtained using the Moessbauer effect facilitate the investigation of electron density variations in the vicinity of an impurity, such as Ta (charge variation $\Delta Z = +1$). This technique is applied to the study of (n,γ) neutron capture in octocoordinated Hf complexes (Hf tetrakis N-benzoyl N-phenyl hydroxylaminate, Hf cupferronate, Hf tetrakis-tropolonate, pentahydrated potassium tetrakis-oxalatohafniate). Hyperfine interactions can be used to determine the damage caused by the capture reaction and to study the vicinity of the nucleus which has undergone the reaction. (France)

29855 EXPERIMENTS ON THE INFLUENCE OF OXYGEN ADSORPTION UPON THE EMISSION IMAGE OF MOLYBDENUM. Mahnert, H. (Technische Univ., Dresden). Phys. Status Solidi (a); 9: No. 1, K5-8(16 Jan 1972).

Studies were made on the orientation contrast as a function of pressure and specimen temperature using the Mo–O system as an example. The results showed that a clean molybdenum surface exhibited a high orientation contrast. The current density ratio between brightest and darkest crystallities attained the value of 20 for thermionic emission, while for uv light release (ultra-high pressure mercury-vapor lamp, quartz lens system) still a ratio of 5 was obtained. The effective work function of the brightest and darkest crystallites was 4.1 and 4.7 eV, respectively. Oxygen intake exerted a drastic influence upon the emission for temperatures below 1000°K when the release was by uv light. The effects of the gas upon the emission and contrast were more limited when a thermionic electron release was used. (P.C.H.)

29856 TEMPERATURE MEASUREMENT IN A LOW-DENSITY MEDIUM WITH AN ATOMIC BEAM. Abramov, V. G.; Afrosimov, V. V.; Gladkovskii, I. P.; Kislyakov, A. I.; Perel, V. I. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1520-5(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1924-32(Sep 1971).

By injecting a monoenergetic atomic beam into a plasma and measuring the velocity distribution of the beam particles scattered through a fixed angle by particle collisions, one can determine the velocity distribution of the neutrals or ions in the plasma. It is shown that the distribution of scattered beam particles reflects the distribution of particles in the medium along a certain spatial direction, which is determined by the injected and scattered particles. The method can be used to study anisotropy in the distribution of particles in the medium, particularly, the direction and velocity associated with collective motion. It is also shown that, in the case of a Maxwellian distribution of particles in the medium, the temperature can be determined by measuring the width of the scattered-particle energy distribution. If the injected and scattered beams are well defined, local temperature measurements can be performed. Experiments were carried out to determine the temperature of a gas heated in an oven to 800 to 2300°K. The gas temperature found from the scattering measurement is in good agreement with the oven temperature as measured with an optical pyrometer. It is shown that this method can be used for local measurements of the ion temperature in a hot plasma. (auth)

29857 TEMPERATURE OF A LOW-DENSITY MEDIUM FROM LIMITING-ANGLE SCATTERING. Afrosimov, V. V.; Kislyakov, A. I. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1526-8(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1933-5(Sep 1971).

A method for measuring the temperature of a low-density gas or plasma is proposed; the method is based on the scattering of a beam of atomic particles with mass m_1 which is greater than the mass of the scattering particles m_2. If the scattering particles m_2 are fixed, there exists a maximum (limiting) angle $\vartheta_{1lim} = \sin^{-1} m_2/m_1$ in the laboratory coordinate system for scattering of particles with $m_1 > m_2$. When the scattering particles have thermal velocities, scattering of the m_1 particles can occur through angles $\vartheta > \vartheta_{1lim}$. Measurement of the particles scattered at $\vartheta > \vartheta_{1lim}$ can be used to find the temperature, and measurement of the intensity of particles scattered with $\vartheta < \vartheta_{1lim}$ can be used to find the particle density in the medium. The method has no high-temperature limitations and is proposed for local measurements of the temperature of hot plasma. (auth)

29858 INFLUENCE OF THE DISCHARGE TUBE ON THE DETERMINATION OF THE PLASMA ELECTRON DENSITY BY MEANS OF CAVITY RESONATORS. Janzen, G. (Univ., Stuttgart). Z. Naturforsch.; 27a: No. 3, 491-9(Mar 1972). (In German).

The eigenvalue equation of a plasma-discharge tube configuration in a cylindrical microwave cavity is derived and solved numerically by an exact theory for TM_{1m0}, TM_{0mn}, and TE_{0mn} resonance modes. The radial and axial electron density profiles are assumed to be homogeneous. The factors of proportionality between electron density and shift of the resonance frequency derived from the linear perturbation theory are compared with the exactly computed eigenvalues. Hence, the range of validity of the linearly computed factors of proportionality (geometry factors) can be established. By considering the influence of the discharge tube, the geometry factors are altered and consequently the sensitivity of the measurement. The influence of the discharge tube can be taken into account by means of suitable correction factors. (auth)

29859 DIAGNOSTICS OF PLASMAS BY LASER-LIGHT SCATTERING. Yokoyama, Masahiro (Osaka Univ., Suita, Japan). Oyo Butsuri; 41: No. 1, 14-23(Jan 1972). (In Japanese).

The theory of light scattering from electrons in the plasma is reviewed, and recent developments in the research on diagnostics of plasma by using laser light scattering and correlation are summarized. (auth) (Japan)

29860 ASYMMETRICAL PARTICLE DENSITY DISTRIBUTION IN A GAS-DISCHARGE PLASMA. Ginzburg, V. M.; Lemkin, V. K.; Rukman, G. I.; Stepanov, B. M.; Filenko, Yu. I. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 16: No. 7, 1227-8 (Jul 1971).

Translated from Radiotekh. Elektron.; 16: No. 7, 1291(Jul 1971).

Interferograms were made of plasma in flash lamps for a current pulse length of 1.5 ms. The laboratory setup consisted of a pulsed laser and a ruby laser amplifier. The interferograms are shown. (M.O.W.)

29861 MICROWAVE INTERFEROMETRY IN HIGH-TEMPERATURE PARTIALLY IONIZED DENSE GASES. Boschi, A.; Merzagora, N.; Tamburrano, A. (CNEN, Rome). J. Appl. Phys.; 43: No. 5, 2160-9(May 1972).

The applicability of microwave interferometry to partially ionized dense gases, such as the gas mixtures used in MHD energy-conversion experiments, is studied. Furthermore, a transmission system is described, which allows coherent microwave transmission through refractory chambers or channels, under extreme conditions of temperature (1000 to 2000°K) and pressure (near atmospheric), overcoming the difficulties in the accessibility. The system was inserted in an arm of a microwave bridge, operating in the "S-mm" band and the apparatus was used for interferometric measurements of electron densities (within 10^{11} to 10^{13} cm^{-3}) in experiments on the nonequilibrium ionization of Cs–He mixtures. (auth)

29862 MEASUREMENT OF THE SPACE POTENTIAL IN PLASMA. Hirao, Kunio; Oyama, Koh-ichiro (Tokyo Univ.). J. Geomagnet. Geoelec.; 23: No. 1, 47-60(1971).

The potential of a probe immersed in the plasma is determined on the basis of the space potential. Therefore, the determination of the space potential has been discussed since the method of using dc probes was established. The problem of the determination of the space potential is studied here from different standpoints, and it is shown that the space potential can be determined within an error of several millivolts. (auth)

29863 EXCITATION DISTRIBUTION OF AN OPEN BARREL-SHAPED CAVITY. Moskalev, I, N.; Stefanovskii, A. M. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 10, 1672-9(Apr 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 10, 2111-20(Oct 1971).

The measurement of the spatial distribution of plasma density by means of microwave cavities requires that higher modes be excited in these cavities. The simplest methods of excitation (apertures or coupling loops) excite a limited number of modes. In the present work the excitation of an axisymmetric cavity by a large number of coupling elements is analyzed; this procedure can be used to establish an excitation field similar in structure to the field of one of the cavity modes. It is shown that this method of coupling a resonator to a waveguide is selective. Relations are found for calculating the parameters of the coupling system required to excite a given mode. Experimental results are reported for the excitation of selected modes in an open, barrel-shaped, 8-mm cavity. (auth)

Kinetics (General)

Refer also to abstract 29008.

29864 (BMBW-FBK-71-13) INVESTIGATIONS ON THE SHOCK TUBE. Carls, H.; Haase, H.; Zuzak, W. (Kiel Univ. (West Germany). Institut fuer Experimentalphysik). Oct 1971. 78p. (In German). Dep. NTIS (U. S. Sales Only).

Investigations were made of plasmas generated in a conventionally driven shock tube. Mainly spectroscopic and interferometric techniques were used. The establishment of local thermodynamic equilibrium is discussed. (auth)

29865 (NP-19250) SIXTH ANNUAL REPORT, 1970. (International Centre for Theoretical Physics, Trieste (Italy)). May 1971. 72p. Dep. NTIS (U. S. Sales Only).

Brief discussions of research work carried out during 1970 are given for the fields of solid-state, plasma, and high-energy physics. The plasma work has centered on instabilities and wave kinetics in toroidal geometries. High-energy physics work concentrated on the following: (1) nonlinear realizations of the quantization of nonpolynomial Lagrangians, (2) Regge poles and duality, (3) interactions of high-energy particles with nuclei, (4) low-energy scattering, and (5) current algebra, chiral symmetry, and scale invariance. Preprints and reports issued during 1970 are listed. (M.O.W.)

29866 PLASMOID TRANSPORT BY QUADRUPOLE AND OCTUPOLE MAGNETIC FIELDS. Demidenko, I. I.; Lomino, N. S.; Padalka, V. G. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1492-5(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1887-92(Sep 1971).

Plasmoid transport in quadrupole and octupole magnetic fields is investigated. The total plasma that moves along the axis, the density at the axis, and the flux incident on the wall have been measured. Good plasmoid transport over distances greater than 100 cm with low particle loss is possible in both configurations, but use of quadrupole configuration requires conductor currents much greater than those for the octupole configuration; fields of higher multipolarity have better transport properties. The particle flux to the wall is modulated because of an interchange instability outside the critical magnetic surface. (auth)

29867 ELECTRICAL POLARIZATION OF A PLASMA STREAM IN AN AXIALLY SYMMETRIC MAGNETIC FIELD. Azovskii, Yu. S.; Guzhovskii, I. T.; Khizhnyak, N. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1496-1501(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1893-1900(Sep 1971).

Experimental and theoretical investigations of the electrical polarization fields in a plasma stream interacting with an axially symmetric magnetic field are described. The experimental and theoretical relationships of the radial and axial polarization fields are compared in inhomogeneous and homogeneous magnetic fields. (auth)

29868 HARMONIC GENERATION AND MULTISIGNAL EFFECTS IN NONLINEAR BEAM–PLASMA SYSTEMS. Konrad, G. T.; Rowe, J. E. (Univ. of Michigan, Ann Arbor). Advan. Electron. Electron Phys.; 29: 1-78(1970).

A historical survey is given to review the dynamics of an assembly of charged particles in a plasma and to review the theory of beam–plasma interactions. Development of the "circuit equation" for the plasma-wave propagation is discussed, including the dispersion equation for a plasma column, and the derivations of the equivalent circuit elements and the circuit equation. Lagrangian formulation data of the beam-plasma interaction equations include discussions on the variation of the electric field across the plasma column, the circuit equation and force equation in Lagrangian coordinates, solution of the large-signal equations, and the one-dimensional equations with beam–plasma collisions included. The solution of the nonlinear equations includes one- and two-dimensional results. The experimental apparatus is described, and results of the rf tests are presented. (4 tables, 55 figs., 73 references). (J.C.W.)

Kinetics (Experimental)

29869 (FRNC-TH-158) STUDY OF THE BEHAVIOR OF La IN ELECTRIC ARC PLASMAS. Antic, Jelisaveta (Paris Univ. (France). Faculte des Sciences). 1971. 115p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Lanthanum was used to study the spectroscopy of the evolution of the thermodynamic conditions of a plasma (conventional carbon arc used in spectroscopy). In this way, fundamental information relating to the problem of the determination of rare earth traces in various substances, particularly other rare earths, was obtained, and the basic ideas necessary to interpret the behavior of rare earths in cold plasma ($T < 10{,}000$°K) were established. The equipment used is described. The conditions under which the La emission takes place are examined empirically: chemical nature of the additives, effect of the current intensity, chemical form of the La sample, nature of the gaseous atmosphere of the arc, and the type of anode used. The results of quantitative analysis for La and Nd are given. A comparison is made between the different methods of measuring the temperature in the plasma arc: measurement of the ratio of two line intensities corresponding to the same species and measurement of the relative intensities of spectral lines of the same ionic spectrum, having known transition probabilities. La and Zn are successively used for temperature estimations. The degree of dissociation, the radial temperature distribution, and the electron pressure are given. (France)

29870 MICROWAVE PLASMA RADIATION. Balakhanov, V. Ya.; Vershkov, V. A.; Zhivotov, V. K.; (and others). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 10, 1772-3(Apr 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 10, 2233-5(Oct 1971).

The microwave radiation from a plasma in a toroidal system with turbulent heating is measured. A spectrum analyzer, based

on a holographic Fourier spectroscopy, records the spectrum in a single pulse. The spectrum has a maximum at the plasma frequency. (auth)

29871 PLASMA FLOW FROM A LONG COAXIAL LINE. Nevolin, V. K.; Tsiberev, V. P.; Tskhakaya, V. K.; Yur'ev, V. A.; Yarygin, V. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 10, 1774-5(Apr 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 10, 2235-7(Oct 1971).

The flow of plasma into vacuum from a long coaxial line with a metal-film thermionic cathode is studied experimentally. The measured flow velocity of the plasma for a given flow rate is proportional to the square of the total current in the coaxial line. The current profiles of characteristic modes measured along the coaxial line have a peak approximately halfway down the line. The experimental results are discussed. (auth)

29872 INDUCED POLOIDAL CURRENT IN A PLASMA STREAM IN AN INHOMOGENEOUS AXISYMMETRIC MAGNETIC FIELD. Azovskii, Yu. S.; Guzhovskii, I. T.; Khizhnyak, N. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1502-8(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1901-9(Sep 1971).

The axial component of the poloidal Hall current in an extended plasma stream in the magnetic field produced by a short coil and by a solenoid was investigated experimentally. It is shown that two poloidal current loops with current flow in opposite directions are observed. The absolute values of these currents are lower in the field of the solenoid than in the field of the short coil, in qualitative agreement with calculations. Changes in the poloidal current in response to increased externally applied magnetic field occur in accordance with the change in the azimuthal induced current; the ratio of the peak values remains almost constant over a broad range of variation in magnetic field, also in qualitative agreement with the calculations. (auth)

29873 ULTRASONIC ATTENUATION IN MAGNETO-THERMALLY PINCHED PLASMA. Tanaka, K.; Odajima, A.; Abe, Y. (Hokkaido Univ., Sapporo). Phys. Lett.; 39A: No. 1, 43-4(10 Apr 1972).

Ultrasound attenuations in n-InSb are measured under the applied dc pulse. The increase of attenuation is observed above the threshold current for pinching and is explained as Akhieser loss in the magnetothermally pinched region. (auth)

29874 EXCITATION TRANSFER IN GAS CLOUD–PLASMA STREAM INTERACTION. Kubo, H. (Tokyo Univ.). Phys. Lett.; 39A: No. 1, 67-8(10 Apr 1972).

H_β was measured in the interaction of hydrogen plasma stream with various gases and it showed the highest intensity when the target gas is helium. This is attributed to the dissociative excitation transfer between excited helium atoms and hydrogen molecules. (auth)

29875 METHOD FOR STUDYING DISTRIBUTION FUNCTION EVOLUTION DURING WAVE–PARTICLE INTERACTIONS. Murakami, M.; Lidsky, L. M. (Massachusetts Inst. of Tech., Cambridge). Rev. Sci. Instrum.; 43: No. 5, 746-8(May 1972).

A gated electrostatic trap was developed that enables experimental observation of the time evolution of particle distribution functions for a wide range of wave–particle interactions. The technique entails trapping of an electron beam in a region where arbitrary wave fields are set up and the analysis of the perturbed distribution function after an arbitrary interaction time. (auth)

Kinetics (Theoretical)

29876 (FRNC-TH-144) STARK EFFECT WITH ISOLATED LINES FROM NEUTRAL ATOMS IN AN INDUCTIVE PLASMA. Assous, Roger (Paris Univ. (France). Faculte des Sciences). 1970. 182p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Quantum and semiclassical theories of inelastic collisions are exposed: the Griem theory for the quadrupolar term of Lindhom; the quantum theory of Seaton; the theory of the effective Gaunt factor. The apparatus used is described, and results are given for Stark-effect measurements made on argon and oxygen lines. In the case of oxygen, the electron density was determined from measurements of the H_β line width and from absolute measurements of the background emission continuum of the plasma. The temperature of the plasma was measured; the transitions observed are given. Transition probabilities in argon obey intermediate coupling rules. The screening effect was neglected. Calculations made using the weak coupling method, the effective Gaunt factor, and the strong-coupling Griem method, are discussed successively. The matrix elements of the dipolar moment of the oxygen atom, and the screening effect are calculated. Quantum calculations of the contributions of strong collisions to the half-widths are also examined. The different calculations established the contributions of strong inelastic and elastic collisions. (France)

29877 (FRNC-TH-164) PLASMA-BEAM INTERACTION IN AN INFINITE MAGNETIC FIELD. APPLICATION TO A RADIALLY INHOMOGENEOUS MEDIUM AND TO HARMONIC GENERATION. Weinfeld, Michel (Paris Univ., Orsay (France)). 1971. 110p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A linear theory is developed for the plasma–beam interaction, the limitation of convective coupling between the slow mode of the beam and the plasma mode of the plasma being imposed. The properties of the system are covered in detail for the case of a homogeneous plasma. A radial distribution of the plasma density, represented by a Gaussian function, is introduced. It is shown that it is possible to describe an inhomogeneous system from the homogeneous medium theory, if simple analogy rules are known. A theoretical study of the generation of harmonics in the weak-turbulence approximation is developed. The experimental equipment and the measurement methods are given. The results of measurements on the general characteristics of the beam–plasma medium and its propagation characteristics in the stable region are given. The experimental results are in agreement with the linear theory. The experimental study of the generation of harmonics demonstrates that the phenomenon agrees with the model presented. (France)

29878 (UCRL-51158) STATISTICAL MECHANICS OF REACTING GASES WITH APPLICATIONS TO THE EQUATION OF STATE OF HYDROGEN. Rogers, Forrest J. (California Univ., Livermore. Lawrence Livermore Lab.). 7 Feb 1972. Contract W-7405-eng-48. 104p. Dep. NTIS.

Thesis.

A method was developed from fundamental statistical mechanics for systematically correcting the ideal gas equation of state (Saha equation) to take into account the interactions that occur in any real gas. At the current stage, all effective two-body interactions that can occur among the various species present in the system are taken into account. Because of the long-range nature of the Coulomb potential, the problem is formulated from the point of view of many-body perturbation theory. It is necessary to use the quantum theory to avoid the short-range divergence of the classical cluster integrals. However, considerable insight into the form of the quantum-mechanical result is obtained from the classical perturbation theory. The result of the many-body perturbation theory is that the Coulomb problem is replaced with a new problem involving the cluster coefficients of the screened Coulomb potential and a large number of other terms associated with plasma interactions. The work is primarily concerned with how atoms are formed out of a plasma as the temperature is lowered: however, ordinary gases are included in a natural way. The method was used to calculate the equation of state of a neutral gaseous electron–proton (hydrogen) system at a moderate density. The corrections to the Saha equation were found to be significant. For the application to hydrogen the second cluster coefficient, which is just the negative of the second virial coefficient, was calculated with the Beth–Uhlenbeck method. This involved detailed numerical calculations of the eigenvalues and phase shifts of the static screened Coulomb potential. (auth)

29879 ARC IN A CYLINDRICAL DIODE WITH AN AZIMUTHAL MAGNETIC FIELD. Potapov, A. V.; Margevich, A. S. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 10, 1684-90(Apr 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 10, 2126-34(Oct 1971).

Using the transport equations for a nonisothermal partially ionized gas in the Grad 13-moments approximation, a system of equations is obtained for a cylindrical discharge in an azimuthal magnetic field in which thermodynamically nonequilibrium composition of the plasma is taken into account. A method for numerical solution of a nonlinear boundary-value problem for a system of ordinary differential equations is given. Profiles of the basic parameters are derived for a plasma produced under conditions characterized by marked thermal interaction between the electron gas and a mixture of heavy particles. The effect of anode temperature on the parameters of the plasma and the effect of current and pressure on the temperature of the heavy component are investigated. (auth)

29880 MOTION OF A CHARGED PARTICLE IN AN ELECTRIC FIELD COMBINED WITH A UNIFORM MAGNETIC FIELD. Borodkin, A. S. (Leningrad Mining Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1461-5(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1845-50(Sep 1971).

A study is reported of the motion of charged particles in a uni-

form magnetic field combined with an electric field, approximating the field between the electrodes of a Penning discharge. With this in mind, the equations of motion of a single charged particle are integrated in cylindrical coordinates. The axial coordinate is obtained as an elementary function of time. The other coordinates are also obtained as elementary functions of time, but in the approximation of small radial oscillations. A new form is obtained for the equipotentials of a combined electric potential. Possible uses of the results are discussed. (auth)

29881 INVESTIGATION OF COLLECTIVE PROCESSES IN A PLASMA BASED ON STIMULATED LIGHT EMISSION. Bessarab, Ya. Ya.; Tkach, Yu. V.; Zeidlits, V. P.; Gadetskii, N. P.; Dyatlova, V. V. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 62: No. 2, 569-72(Feb 1972). (In Russian).

It is demonstrated that coherent light emission may be employed for investigation of collective processes in a plasma–beam discharge. The spectrum of oscillations excited in interaction between the electron beam and plasma is investigated by Fourier analysis of the intensity fluctuations of the coherent radiation from the discharge. An expression is obtained for the frequencies restricting the range of applicability of the method. Frequencies generated by the photodetector are taken into account during treatment of the spectrograms. (auth)

29882 QUANTUM ELECTRODYNAMICS OF NONTHERMAL RELATIVISTIC PLASMAS: KINETIC THEORY. Bezzerides, B. (Stanford Univ., Palo Alto, Calif.); DuBois, D. F. Ann. Phys. (N. Y.); 70: No. 1, 10-66(Mar 1972).

A general covariant framework for treating ultrarelativistic plasmas is developed by combining the Green's function theory of nonequilibrium statistical mechanics with modern quantum electrodynamics. The collective-mode properties of such plasmas are treated in a covariant manner with electron–positron pair creation and annihilation included. A set of covariant coupled (collisional) kinetic equations for particles and radiation is derived in the weak-coupling limit. The wave–particle interactions are consistently separated into adiabatic and nonadiabatic parts, depending on whether or not the wave quanta damp away quickly on the space–time scale of macroscopic changes in the system. The adiabatic terms are shown to lead to collision rates equal to the appropriately averaged Moeller or Bhabba rates for electron–or electron–positron scattering with dynamically screened internal photon propagators. The nonadiabatic terms, inconsistently ignored in previous work, lead to collision rates describable as Cherenkov emission and absorption of quanta. These covariant, nonadiabatic terms consist of resonant and nonresonant parts analogous to terms arising in the familiar classical, nonrelativistic quasi-linear approximation. The classical limit of these kinetic equations is taken to compare with previous work, although this limit is of restricted usefulness for highly relativistic plasmas. Further applications of these techniques are discussed, and it is shown that the identification of higher-order radiative processes (e.g., bremsstrahlung vs Compton scattering) depends on the separation of the wave spectrum into adiabatic and nonadiabatic parts. (auth)

29883 AXISYMMETRIC PLASMA FLOWS IN EXTERNAL MAGNETIC FIELDS WITH HALL EFFECT. Robert, K. (DFVLR-Institut fuer Angewandte Gasdynamik, Porz, Ger.). Z. Naturforsch.; 27a: No. 3, 500-12(Mar 1972).

The present analysis refers to steady, barotropic, and inviscid flows of rarefied-gas plasmas, both as a free jet and within a cylindrical channel, with superimposed electric current, under the influence of an axisymmetric external magnetic field. The nondimensionalized equations of magnetogasdynamics are linearized by expanding the unknown functions in double power series in terms of the magnetic force number and the magnetic Reynolds number, both assumed smaller than one. For Hall parameters sufficiently small and slightly curved magnetic lines of force, closed form solutions for the electric current density, as well as plasma velocity and mass density are derived and discussed. Increases in the axial velocity component are achieved more efficiently by using a free jet rather than channel flow. (auth)

29884 KINETICS OF NONSTATIONARY PROCESSES IN ELECTRICAL DISCHARGES. I. INITIAL MODEL EQUATIONS FOR NONSTATIONARY PROCESSES IN A PLASMA DISCHARGE. Vasil'ev, S. S. (Moscow Inst. for Light Industrial Tech.). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 9, 1275-7(Sep 1971).

Translated from Zh. Fiz. Khim.; 45: No. 9, 2255-9(Sep 1971).

All quantities that characterize the plasma in nonstationary discharge processes are functions of time. Model equations for the time changes of the directional and the thermal velocity of electrons, and of their concentration, can be set up to describe changes in the state of the plasma. By combining these equations with Ohm's law, one obtains an equation for the resistance per unit length of the discharge region. This resistance is kept constant (or made to increase) during the initial measurements of the state of the plasma: under these conditions the discharge should have a "rising" current–voltage characteristic. The excitation and chemical activation processes of the molecules should be enhanced in discharges of this type. (auth)

29885 KINETICS OF NONSTATIONARY PROCESSES IN ELECTRICAL DISCHARGES. II. CONDITIONS FOR THE APPEARANCE OF AN ACTIVE OVERPOTENTIAL IN THE DISCHARGE VOLUME. Vasil'ev, S. S. (Moscow Inst. for Light Industrial Tech.). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 9, 1277-9(Sep 1971).

Translated from Zh. Fiz. Khim.; 45: No. 9, 2260-4(Sep 1971).

Changes in the potential applied to a gas discharge may be followed by a steady, a falling, or a rising potential gradient in the active resistance of the discharge. The latter case corresponds to the appearance of an "active overpotential" in the discharge column, with an increase in the electron temperature of the plasma. An analysis of the equivalent circuit of the gas discharge volume shows that the active overpotential goes through a maximum when the frequency of the applied field is varied. Hence, there must be a range of frequencies for which the high-frequency discharge has a maximum efficiency as a source of molecular excitation and of activation of chemical reactions in the plasma. (auth)

29886 KINETICS OF NONSTATIONARY PROCESSES IN ELECTRICAL DISCHARGES. III. ENHANCED FREQUENCY OF EFFECTIVE COLLISIONS BETWEEN ELECTRONS AND NEUTRAL PARTICLES UNDER NONSTATIONARY DISCHARGE CONDITIONS. Vasil'ev, S. S. (Moscow Inst. for Light Industrial Tech.). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 9, 1279-82(Sep 1971).

Translated from Zh. Fiz. Khim.; 45: No. 9, 2265-9(Sep 1971).

A modification of the Arrhenius equation for the frequency of effective collisions between electrons and molecules, which allows explicit calculation of the effect of electron temperature on the collision frequency under nonstationary conditions, is discussed. The modified form of the equation can account for many physical properties of pulsed, high-frequency, and mixed discharges, and also for the enhanced influence of high-frequency and self-oscillating discharges on the electrical oxidation of nitrogen. (auth)

29887 HIGH-FREQUENCY CONDUCTIVITY AND SUM RULES IN NONLINEAR PLASMA RESPONSE THEORY. Golden, K. I.; Silevitch, M. B. (Northeastern Univ., Boston). Lett. Nuovo Cim.; 3: No. 14, 605-7(1 Apr 1972).

Sum rules are developed for the longitudinal projection of external conductivity, starting from an hf denominator expansion of the real part of the double Hilbert transform. (M.O.W.)

29888 NUMERICAL SOLUTIONS TO THE HELICON BOUNDARY-VALUE PROBLEM. Wentland, N. L.; Merrill, J. R. (Dartmouth Coll., Hanover, N. H.). Contract AT(30-1)-4186. J. Comput. Phys.; 9: No. 1, 138-58(Feb 1972).

Numerical methods are applied to the helicon boundary-value problem. A method of solution is described that is completely general and independent of both the geometry and the detailed form of the resistivity tensor. This approach is applied to two particular geometries under the assumption of a free-electron-gas model. The first geometry is the infinite plate perpendicular to the magnetic field. In this case, excellent agreement with the analytic solution of Chambers and Jones is found. For the second geometry, a finite rectangular parallelepiped, a solution is found that is qualitatively and semiquantitatively correct. These calculations allow the continued use of helicon experiments to measure topological features of Fermi surfaces in metals. In the absence of calculations such as those presented, crude approximations to the boundary value solution have been used without any way to check their theoretical validity. (auth)

29889 SOLUTIONS OF THE FOKKER–PLANCK EQUATION IN DETAILED BALANCE. Risken, H. (Univ., Stuttgart). Z. Phys.; 251: No. 3, 231-43(1972).

The solutions of the Fokker–Planck equation in detailed balance are investigated. Firstly, the necessary and sufficient conditions obtained by Graham and Haken are derived by an alternative method. An equivalent form of these conditions in terms of an operator equation for the Fokker–Planck Liouville operator is given. Next, the transition probability is expanded in terms of a biorthogonal set of eigenfunctions of a certain operator L. The necessary and sufficient conditions for detailed balance leads to a simple operator equation for L. This operator equation guarantees that only half of the biorthogonal set needs to be calculated. Finally the dependence of the eigenvalues on the reversible and irreversible drift coefficient is discussed. (auth)

29890 STATIONARY ROTATING INCOMPRESSIBLE PLASMAS WITH MINIMUM INTERNAL LOSSES. Schaefer, D. (Univ., Bonn). Beitr. Plasmaphys.; 11: No. 5, 383-92(1971). (In German).

The condition that the Ohmic and the friction losses are minimized leads to the assumption that both the magnetic field H and the velocity field v are Trkal fields, rot H = αH and rot v = βv. In the rotationally symmetric stationary case, the boundary conditions and the condition that the toroidal part of v and H should vanish on the boundary, lead to a linear eigenvalue problem for α, β which, in case of a rectangular domain, can be easily resolved. It follows that $\alpha = \beta$ and v = const H. (auth)

29891 QUANTUM-STATISTICAL FUGACITY EXPANSIONS FOR PARTIALLY IONIZED PLASMAS IN EQUILIBRIUM. Bartsch, G. P.; Ebeling, W. (Univ., Rostock, Ger.). Beitr. Plasmaphys.; 11: No. 5, 393-403(1971).

A derivation of screened fugacity expansions for nondegenerate Coulomb systems is given. Debye screening is taken into account by an iteration procedure. The fugacity expansion is applied to hydrogen plasmas. It is shown that the fugacity expansion of the pressure implicitly describes the ionization equilibrium. (auth)

29892 VARIATIONAL AND STATISTICAL METHODS FOR AN ELECTRON PLASMA WITH SELF-CONSISTENT FIELD INTERACTION. Wilhelm, H. E.; Kim, S. H. (Colorado State Univ., Fort Collins). Nuovo Cim.; 8B: No. 2, 307-20(11 Apr 1972).

The Lagrange and Hamilton functions, and the Liouville equation are developed for an adiabatic electron plasma in which the charged particles interact by the self-consistent electric field. The electrohydrodynamic field equations are obtained by variation of the Lagrangian and functional derivation of the Hamiltonian. As an application, the statistical distribution function of the fluctuations in the Lagrangian conjugate fields is derived for the case of fully developed turbulence as that solution of the Liouville equation which maximizes the entropy of turbulence. It is shown that the statistical distribution is in quasi-Gaussian form relative to the velocity field fluctuations and the electric field fluctuations. The deviations from the Gaussian are produced by nonlinear terms of higher order resulting from adiabatic density and electric field fluctuations. (auth)

29893 DISPERSIVE TRANSPORT COEFFICIENTS FOR IONIZED GASES. Steinert, L. A. (Douglas Aircraft Co., Long Beach, Calif.). Transp. Theory Statist. Phys.; 1: No. 3, 163-82(1971).

A study was made on transport processes in ionized gases, for which a nonrelativistic transport theory based upon dynamical responses to mechanical actions was converted into a hydrodynamic formalism by an internal reorganization of the driving forces. The mechanical forces were replaced with appropriate nonmechanical perturbations in the form of hydrodynamic quantities by direct elimination between redundant transport equations. All the available symmetry properties of the physical system were invoked to predetermine general parametric forms for the transport equations by prescribing precisely defined scalar functions acting in the role of ordinary transport coefficients, but with frequency and wavenumber dependence. This explicit categorization of the transport functions is independent of any approximations involved in actual calculations of the transport coefficients per se. The generality of the transport coefficients derives from the fact that the entire past history of a given transport process is taken into account by the present definition, in contrast to ordinary definitions of transport coefficients. Because of this feature, the present transport coefficients are referred to in a quasi-fluidic sense as distinguished from the usual history-independent transport parameters which depend only upon thermodynamic variables. As a specific example, calculations are presented for a dilute electron gas in which the electron–electron collision frequency and the driving signal frequency are of the same order of magnitude, but the wavenumber dependence is suppressed as being of negligible importance. (auth)

29894 BOLTZMANN EQUATION FOR A PHOTON GAS INTERACTING WITH A PLASMA. Gould, Robert J. (Univ. of California, San Diego, La Jolla). Ann. Phys. (N. Y.); 69: No. 2, 321-48(Feb 1972).

The dynamics of a photon gas is described in a Boltzmann-equation formulation for the rate of change of the photon occupation number. The interaction with the electron component of a hydrogen–helium plasma by Compton scattering is introduced as a Fokker–Planck operator. This operator, as well as the total energy exchange rate by Compton scattering, is derived by simple physical arguments from the limiting formula for the case of a zero-temperature nondegenerate electron gas; the effects of stimulated scattering are discussed. Photon production by various atomic processes (bremsstrahlung, direct radiative recombination, line emission, and 2s–1s two-photon continuum emission) is described as source terms in the Boltzmann equation. The spontaneous emission by these atomic processes is conveniently described in terms of the basic bremsstrahlung term, which dominates the other atomic processes for $kT_e \gtrsim 1$ Ry; at lower temperature the other processes, which involve bound atomic states, dominate. Absorption and stimulated emission by the atomic processes are discussed briefly. The process of radiative Compton scattering (double Compton scattering) is evaluated in the limit of low photon energies for interaction with a zero-temperature electron gas; this process is shown to be negligible compared with bremsstrahlung for the important application to the problem of the primordial plasma and photon gas. (auth)

29895 ELECTRON ENERGY DISTRIBUTION FUNCTION OF PURE HELIUM IN CYCLOTRON RESONANCE. Un, C. K. (Univ. of Maine, Portland); Lutz, B. C. J. Appl. Phys.; 43: No. 5, 2193-6(May 1972).

The Boltzmann equation was solved for the energy distribution function of electrons of pure helium bounded in a circular cylindrical medium under the influence of a high-frequency electric field and an externally applied dc magnetic field with the directions perpendicular to one another. The behavior of the electron energy distribution function at and near cyclotron resonance was examined. (auth)

29896 STIFF SYSTEMS OF KINETIC EQUATIONS: A PRACTITIONER'S VIEW. Gelinas, Robert J. (Univ. of California, Livermore). J. Comput. Phys.; 9: No. 2, 222-36(Apr 1972).

An ever increasing number of current problems in applied science are described by sets of kinetic equations which may suffer from the difficulty known as stiffness when numerical solution of the equations is attempted. The common causes and effects of stiffness are examined from a general user's point of view. Generally available measures for alleviating this type of difficulty are indicated. A specialized routine designed specifically for stiff systems is applied to a kinetic model of photochemical smog. Performance of the specialized routine is compared to a standard Adams predictor-corrector method as well as to the results obtained by another standard kinetics code which was originally applied to this model problem. Finally, the admissibility of quasi-steady state assumptions on selected components in this system model is examined. (auth)

Production

29897 PLASMA BEAM PRODUCED BY A PENNING DISCHARGE WITH A STRONG RADIAL ELECTRIC FIELD. Golovanivskii, K. S.; Guseinova, A. D. (Univ. of International Friendship, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1484-7(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1876-80(Sep 1971).

It was established experimentally that the plasma produced in a Penning discharge can display an anisotropic electron temperature, because electrons are accelerated perpendicularly to the magnetic field by the strong radial electric field which excites the discharge. The electron temperature becomes more anisotropic as the anode voltage is increased; the maximum anisotropy factor is $T_{e\perp}/T_{e\parallel} = 5$. The electron density in the plasma which diffuses outside the source without an auxiliary extraction of ions is as high as 10^{10} cm^{-3}. The velocity distribution of the electrons is approximately Maxwellian. The directed motion of ions under these experimental conditions was also studied. An explanation is given for the mechanism by which ions are separated into two longitudinal energy groups. (auth)

29898 ENERGY CHARACTERISTICS OF A COAXIAL PLASMA SOURCE. Belikov, A. G.; Goncharenko, V. P.; Goncharenko, D. K.; (and others). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1488-91(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1881-6(Sep 1971).

The choice of parameters for a coaxial source is discussed. The energy characteristics of a source constructed on the basis of these relations were checked experimentally. The plasmoid energy is found to increase in proportion to the energy stored in the source bank. The total plasmoid energy exceeds 1 kJ. The possibility of producing purely hydrogen plasmoids is demonstrated. (auth)

29899 IONIZATION FLUCTUATIONS IN GASES. Alkhazov, G. D. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1540-6(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No, 9, 1949-57(Sep 1971).

The average energy W expended on the formation of electron–

ion pairs and the Fano factor F for ionization of noble gases and hydrogen by nonrelativistic electrons are calculated approximately. The calculated values of W agree with experimental values, and the values of F for H, He, Ne, Ar, and H_2 are 0.39, 0.21, 0.13, 0.16, and 0.34, respectively. When there is an additive with a low ionization potential in a noble gas, F decreases and can reach a value as low as 0.05. (auth)

29900 LASER-INDUCED GAS BREAKDOWN: SPECTROSCOPIC AND CHEMICAL STUDIES. de Montgolfier, Ph.; Dumont, P.; Mille, Y.; Villermaux, J. (Univ. of Wisconsin, Madison. CNRS, Nancy). J. Phys. Chem.; 76: No. 1, 31-7 (6 Jan 1972).

These experiments included time-resolved spectroscopy, direct detection of H atoms with a TiO_2 probe, and chemical reactions; each of them provided insight into the behavior of the medium at different times. The spectroscopic study allowed one to isolate three effects contributing to the emission of light from the plasma: the bremsstrahlung radiation of the electrons, the line emission of the atoms or molecules, and a third peak which might correspond to an emission of light occurring in a supersonic blast in the direction of the laser. Comparison of the intensity of both the bremsstrahlung and line radiation with the number of H atoms, detected in a flow of hydrogen irradiated with the laser beam, showed that atoms were probably created during collisions with electrons. Chemical reactions and explosions were initiated by the laser beam when a plasma was created. No primary multiphotonic absorption and no macroscopic chemical reactions were observed below the breakdown threshold. (auth)

29901 ELECTRON IMPACT IONIZING COLLISIONS IN GASEOUS MEDIA IN THE PRESENCE OF WEAK rf SIGNALS. Chiplonkar, V. T.; Desai, Y. R. (Inst. of Science, Bombay). Indian J. Pure Appl. Phys.; 9: No. 9, 759-60(Sep 1971).

Weak rf signals perturbing a plasma were shown to enhance or inhibit ionization due to alteration in the average value of the total ionization cross section of neutral atoms for electron impact. (auth)

29902 MICROWAVE PLASMA GENERATION BY END-ON AND SIDE-ON IRRADIATION IN THE PRESSURE RANGE 0.1 TO 10 mTORR OF HYDROGEN. Unsoeld, Eberhard (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Z. Phys.; 251: No. 3, 254-70(1972).

Investigations were made of hydrogen plasmas produced by means of linearly polarized microwaves (f = 2.45 GHz, P_0 = 2.2 to 5.0 kW). A superimposed uniform and stationary magnetic field $\vec{B}_z$ is tuned in most of the experiments to the electron cyclotron resonance. The rf is coupled to the plasma by different antennas. A conical horn is used for end-on irradiation (wave vector $\vec{k} \| \vec{B}_z$). With regard to toroidal discharge geometries, the side-on irradiation $\vec{k} \perp \vec{B}_z$ is of particular interest. For this purpose two new T-shaped antennas were developed. In the pressure range investigated, the plasma produced by the microwaves fills up the whole discharge vessel (l = 200 cm, V ≈ 10^4 cm^3). The electron densities are in the range between 2.5×10^{10} and 1.5×10^{11} cm^{-3} and the electron temperatures between 1.2 and 5.0 eV. The plasma produced by side-on rf irradiation ($\vec{k} \perp \vec{B}_z$, $\vec{E} \| \vec{B}_z$) is used as a preionization plasma for a z-pinch discharge. The degree of ionization obtained in this way is ≳5%. The optimum conditions for this type of preionization are evaluated from density measurements at higher cyclotron harmonics. (auth)

29903 PROPERTIES OF PLASMA PRODUCED BY HIGH POWER LASER. Waki, Motoichiro (Osaka Univ.); Yamanaka, Tatsuhiko; Kang, Hyung-boo; Yoshida, Kunio; Yamanaka, Chiyoe. Jap. J. Appl. Phys.; 11: No. 3, 420-1(Mar 1972).

The electron temperature and reflectivity of a plasma produced by a 2.3- to 10-nsec laser pulse was measured. An oscillation of reflectivity was found that seems to be caused by the ion acoustic waves. Diagrams are given. (M.O.W.)

29904 PRODUCTION OF HIGH-ENERGY IONS IN LASER-PRODUCED PLASMAS. Allen, F. J. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). J. Appl. Phys.; 43: No. 5, 2169-75(May 1972).

Several reported experiments are analyzed to show that acceleration in transient electric fields is an unlikely means of production of the highly energetic ions observed in laser-produced plasmas. Alternative mechanisms which appear capable of accounting for the observed results are proposed and discussed. (auth)

29905 RELATION BETWEEN THE JUMPS IN ELECTRON TEMPERATURE, POTENTIAL, AND MAGNETIC FIELD ACROSS A COLLISIONLESS PERPENDICULAR SHOCK. Cairns, R. A. (Univ. of St. Andrews, Scotland). Phys. Lett.; 38A: No. 6, 445-6(13 Mar 1972).

Using a previously proposed theory of electron heating in a collisionless perpendicular plasma shock wave, a simple relation between the quantities is derived and compared with experiment. (auth)

29906 DENSE PLASMA DRIVER. Kuswa, G. W.; Freiwald, D. A. (Sandia Labs., Albuquerque, N. Mex.). J. Appl. Phys.; 43: No. 5, 2226-8(May 1972).

Plasma from a short coaxial accelerator operated in 5-torr deuterium was channeled through a conical section into a 5-cm-diam Pyrex expansion section where dense ($n_i \sim 10^{18}/cm^3$) high-velocity (~8.5 cm/μsec) plasmas were observed, as determined from difference holograms and streak camera photos. (auth)

Stability

29907 (FRNC-TH-162) MICROINSTABILITIES IN A PLASMA PENETRATED BY AN HF ELECTROMAGNETIC FIELD. Teichmann, Jiry (Paris Univ., Orsay (France). Faculte des Sciences). 1971. 87p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

It is shown that an hf electromagnetic field with a dominant magnetic component can change the dielectric properties of a plasma in such a way as to totally or partially suppress most of the microinstabilities. It is also shown that the field of a right-hand polarized wave propagated along the magnetic field is preferred for the efficient stabilization of loss cone type perturbations and cyclotron instabilities. It is demonstrated that the most important mechanism involved in the stabilization is the periodic displacement of the lines of force of the associated magnetic field. The effect of different hf electric components is discussed in detail. Collisions do not change the principal stabilization mechanism. It was possible to classify the microinstabilities in collisionless plasmas into two groups: modes in which the dispersion is determined by the interaction between electrons and ions; such modes are very susceptible to the effects of the hf field; oscillations excited by the collective processes due to a single species of particles which are comparatively insensitive to the hf field. The physical consequences of the stabilization mechanism can be applied to the development of a device for diagnosing such instabilities. (France)

29908 (IPP-1/118) EXPERIMENTAL INVESTIGATION OF THE MICROINSTABILITY IN THE PISTON-REGION OF A MAGNETOSONIC SHOCK WAVE. Niedermeyer, Helmut (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Jul 1972. 62p. (In German). Dep. NTIS (U. S. Sales Only).

A microinstability responsible for anomalous magnetic field diffusion and collisionless dissipation in magneto-acoustic compression waves with plasma parameters $\beta < 10^{-2}$, $T_e/T_i > 1$, ω_{pi}/ω_{ce} = 0.01 to 1 was investigated experimentally. In a radially homogeneous plasma column ($n < 3 \times 10^{12}$ cm^{-3}, $B_0 < 500$ G) generated by uv, preionization compression waves were excited by a fast theta pinch (coil diameter 43 cm) fed by a Blumlein line. The time development of the magnetic field profile measured by a fast miniature probe showed an anomalous field diffusion in the region of the magnetic piston. In this region magnetic field oscillations with frequencies of 0.3 to 0.5 ω_{pi}, growth rates of about half that frequency, and amplitudes up to 10 G were observed. Simultaneously, electric field fluctuations with amplitudes of 5 kV/cm were measured spectroscopically by the helium-satellite method. A numerical study of the linear dispersion relationship predicts electron-cyclotron waves to be the most unstable ones, with frequencies and growth rates corresponding to the observed values. (auth)

29909 (ORNL-TM-3642) NONLINEAR EVOLUTION OF LOSS-CONE FLUTE MODES. Eldridge, Owen (Tennessee Univ., Knoxville. Oak Ridge National Lab., Tenn.); Crume, E. C.; Meier, H. K. (Oak Ridge National Lab., Tenn.). Feb 1972. 15p. Dep. NTIS.

A class of linearly unstable loss-cone flute modes is investigated by computer simulation and nonlinear theory. The instability occurs through the coupling of a negative-energy ion cyclotron wave with the lower hybrid mode of a cold ion component. Stabilization occurs through a rapid and efficient heating of the cold ions, with very little energy appearing in electric fields. The analytic theory is in qualitative and quantitative agreement with the results of the simulation. (auth)

29910 GRAVITATIONAL INSTABILITY OF A PLASMA WITH HALL EFFECT. Mattei, G. Boll. Unione Mat. Ital., Ser. IV; 3: No. 2, 230-41(Apr 1970). (In Italian).

An analytical study was made of the gravitational instability of a compressible plasma in a homogeneous magnetic field B. It supplemented the Ohm law by a Hall term in a magnetohydrodynamic approach. The perturbations are assumed axisymmetric around B. It is shown that for wave numbers parallel to B, smaller than a critical one k_c, the perturbations are unstable. The sta-

bility limit k_c is independent of the Hall effect, as well as of a finite electric conductivity or uniform rotation about B of the plasma. The problem has no implications in applied mechanics. (App. Mech. Rev.)

Thermonuclear Processes

Refer also to abstract 27862.

29911 (AEC-tr-7293) REPORT BY STUDY GROUP ON FUSION REACTOR. Amano, Yurusu; Furukawa, Kazuo; Hiraoka, Toru; Matsunaga, Sakuro; Mori, Shigeru; Ogawa, Yutaka; Ota, Mitsuru; Sanogawa, Yoshibo; Tanaka, Seishun; Yamato, Harumi (Japan Atomic Energy Research Inst., Tokyo). Translation of report JAERI-Memo-4152. 143p. Dep. NTIS.

This is the report by the Work Group on Nuclear Fusion covering the period from December, 1969 to March of the following year and which was compiled with the cooperation of the participating laboratories of the Tokai district. The various aspects of nuclear fusion are discussed by eight authors in seven separate chapters. The themes of these chapters include the overall concept of a nuclear fusion reactor, neutron behavior in a blanket, materials, radiation damage to the vacuum wall, tritium production, superconducting magnets, and heat removal. A bibliography is appended. (auth)

29912 (AEC-tr-7302) NUCLEAR FUSION REACTOR, ITS CONCEPT AND PROBLEMS. Mori, Shigeru; (and others). Translated from Nippon Genshiryoku Gakkaishi; 13: No. 5, 275-95(1971). 45p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 26: 5541. (M.O.W.)

29913 (COO-3421-3) POTENTIAL WELL FORMATION IN AN ELECTROSTATIC CONFINEMENT DEVICE. Black, Wilson Murray (Pennsylvania State Univ., University Park. Dept. of Electrical Engineering). Dec 1971. 151p. Dep. NTIS.

Thesis.

The potential profile of an electrostatic confinement device is obtained experimentally and analytically to determine conditions that are conducive to the formation of a potential well. Either ions or electrons may be radially injected into the confinement device, which consists of 3- and 6-m-diameter concentric spherical grids. The outer grid potential is near ground, and the inner is −2 to −8 kV for ion injection and +2 kV for electron injection. In either mode the particles are injected near the outer grid and focused into the center, thereby creating a space-charge region. The degree to which the resulting electric fields alter the potential profile to form a potential well is of central interest. An electron beam probe technique was developed to determine the potential profile of this confinement device. The potential is computed from observed deflections of a collimated beam of electrons incident upon the device at selected impact parameters. The performance of this technique is evaluated. (M.O.W.)

29914 (IPP-2/200) PRELIMINARY STUDY OF A PHOTOIONIZED-BARIUM PLASMA SOURCE FOR THE W IIa STELLARATOR. Ishii, S.; Ohlendorf, W. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Oct 1971. 28p. Dep. NTIS (U. S. Sales Only).

A source of photoionized barium plasma from metastable atoms is developed for study on the W IIa stellarator. An ion flux of 2×10^{12} sec^{-1} is obtained. (auth)

29915 (IPP-6/101) EFFECT OF PLASMA FLOW ON TOROIDAL CONFINEMENT. Green, B. J. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Jan 1972. 49p. Dep. NTIS (U. S. Sales Only).

An attempt is made to review recent developments in the study of plasma flow and its effect on toroidal plasma confinement. The topic is presently the object of active research, so that this summary will serve rather as a progress report of development. The different approaches to the problem are classified and discussed in such a way as to indicate the status of results that have been achieved and to highlight the outstanding problems. (auth)

29916 (UCID-15944) ESTIMATE OF RADIATION FLUXES EXPECTED TO HIT FIRST WALL OF DT AND D^3He MIRROR REACTORS. Lee, Joseph D. (California Univ., Livermore. Lawrence Radiation Lab.). 11 Nov 1971. 10p. Dep. NTIS.

Mirror reactor first walls are expected to be exposed to neutral atom, photon, and neutron radiation. An attempt is made to estimate the intensity of these in conceptual 1000-MW(e) DT and D^3He reactors. (auth)

29917 LONGITUDINAL ION BEAMS IN A CLOSED MAGNETIC TRAP. Berezhetskii, M. S.; Grebenshchikov, S. E.; Kossyi, I. A.; Sbitnikova, I. S.; Shpigel, I. S. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 2, 573-7 (Feb 1972). (In Russian).

A quasi-stationary longitudinal (directed along the small axis of the toroidal chamber) ion beam is observed in a closed magnetic mirror (stellarator L-1). The main dependences of the beam on magnetic field characteristics are studied. The distribution of the beam density along the chamber cross section and time variation of the beam are studied. The mechanism leading to the appearance of the ion beam is mainly connected with escape from the plasma of ions trapped by the toroidal magnetic field. In the presence of radial electric fields the escape of the trapped ions is accompanied by the appearance of a recoil momentum in the remaining plasma. Such ion beams may also arise in other types of toroidal magnetic traps (e.g., in tokamaks). (auth)

29918 PULSED EROSION PLASMA ACCELERATOR. Kalygin, A. G.; Kozlov, N. P.; Koreshchenko, N. A.; Leskov, L. V.; Saenko, V. B. (Moscow Technical Coll.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 10, 1650-3(Apr 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 10, 2084-7(Oct 1971).

The electron density distribution and electric and magnetic fields in a rail plasma accelerator of the erosion type were investigated, using electric and magnetic probes and an instrument employing the Tepler method. (auth)

29919 100 kV, FAST, HIGH ENERGY, NONUNIFORM FIELD DISTORTION SWITCH. Post, R. S.; Chen, Y. G. (Columbia Univ., New York). Rev. Sci. Instrum.; 43: No. 4, 622-4(Apr 1972).

A fast-closing, high-voltage, high-energy, nonuniform field distortion switch was developed. This switch, filled with free-flowing, one-atmospheric sulfur-hexafluoride gas, operates in the cascade mode, and is able to handle 36 kJ at 85 kV. These switches have been tested and put into operation with the Columbia high-voltage capacitor bank. The overall jitter between the six switches used is less than 10 nsec at 85 kV. (auth)

29920 FUSION OF ELECTRON-BEAM-ACCELERATED IONS. Goldenbaum, G. C. (Naval Research Lab., Washington, D. C.). Phys. Lett.; 39A: No. 1, 17-18(10 Apr 1972).

The enhancement of neutron output when a pulsed electron beam is injected into a plasma is interpreted in terms of acceleration of a small fraction $(\delta n/n) \approx 10^{-1}$ of plasma ions to MeV energies. (auth)

Wave Phenomena

29921 (FRNC-TH-152) EXCITATION AND AMPLIFICATION OF ACOUSTIC WAVES BY PLASMAS. Fitaire, Marc (Paris Univ., Orsay (France). Faculte des Sciences). 1971. 138p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A linear theory for the excitation and amplification of acoustic waves by reactive gaseous media is presented. Beginning with the equation for the propagation of acoustic waves along sound tubes, the damping of such waves in a finite length of neutral or weakly ionized gas is evaluated. Excitation and amplification effects were established in plasmas. Acoustic waves were excited in the plasma of microwave frequency or continuous discharges by the action of a low-frequency modulated electric field, this field acting on the plasma by means of a resonant cavity or an electrostatic probe. It was verified that the electron density of a plasma in which an acoustic wave is propagated is modulated by this wave and that the excitation term is proportional to the time derivative of the energy exchange between the electrons and the neutrals. It was found that, within the acoustic wave, the charged particles oscillate in phase with the pressure fluctuations of the neutrals. A significant reduction in the damping of the acoustic wave propagated along the discharge tube was observed; this damping was studied as a function of the frequency of the wave and the plasma parameters. Most of the experiments were performed in Ar, and some of them in He. (France)

29922 (NP-19257) INVESTIGATION OF THE OSCILLATION FREQUENCY IN THE L-1 STELLARATOR BY A CORRELATION METHOD. Berezhetskii, M. S.; Grebenshchikov, S. E.; Kossyi, I. A.; Sbitnikova, I. S.; Shpigel, I. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1971. 43p. (In Russian). Dep. NTIS (U. S. Sales Only).

Plasma instability in magnetic collectors is of direct interest to controlled thermonuclear synthesis; this paper describes a study of large-scale long-wave oscillations in the L-1 Stellerator with the aid of a correlation method. Amplitude–time fluctuations, measurement of long-wavelength oscillations, measurement of radial domain of correlation, and the determination of azimuthal dimensions of the fluctuations and of azimuthal phase velocity are

discussed. It was established that in the L-1 Stellerator azimuthal modes of oscillation are determined by the structure of the vacuum magnetic field and depend on the magnitude of the field strength. (K.S.W.)

29923 LANGEVIN EQUATION OF WEAK TURBULENCE. Elsaesser, Klaus (Max-Planck-Institut fuer Physik and Astrophysik, Munich); Graeff, Pitter. Ann. Phys. (N. Y.); 68: No. 2, 305-36(Dec 1971).

The hierarchy equations describing weakly interacting waves in a fluid are solved by the method of characteristic functionals, combined with the time-asymptotic method of Bogolyubov and Mitropolski. The result to lowest nontrivial order allows one to characterize the stochastic state of the fluid in close analogy to the Brownian motion of a test particle: All fluid quantities look in the stochastic sense, like solutions of a Langevin equation; i.e., they consist of a friction term into which the initial values (at t = 0) enter and a stochastically independent term which represents a Gaussian noise (turned on at t = 0). The pure Gaussian case and the realizability conditions of the full approximation scheme are discussed. It is clear that, for the lowest order, the positivity of the probability measure is ensured because of the existence of the model equation mentioned above. (auth)

29924 EFFECT OF ACCELERATION OF SLOW ELECTROMAGNETIC WAVES ON RADIATION FROM AN INHOMOGENEOUS BEAM–PLASMA SYSTEM. Aleksandrov, V. O.; Zhilinskii, A. P.; Fedorov, V. I. (Leningrad Polytechnical Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 10, 1769-71(Apr 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 10, 2230-3(Oct 1971).

The power radiated perpendicularly to the axis is investigated as a function of plasma density and external magnetic field. It is shown that in strong magnetic fields ($\omega_H^2/\omega^2 \gg 1$) slow electromagnetic waves that propagate in the plasma can be accelerated by a suitable choice of the magnetic field or density distribution. A considerable increase in the radiated power occurs under these conditions. Good agreement is obtained between the theoretical and experimental results. (auth)

29925 ION ACOUSTIC TURBULENCE IN A PLASMA LOCATED IN A MAGNETIC FIELD. Kuznetsov, E. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 62: No. 2, 584-92(Feb 1972). (In Russian).

Turbulence of ion sound in a plasma located in a magnetic field is considered. In a sufficiently dense plasma ($\omega_{pi} \gg \omega_{Hi}$, where ω_{pi} and ω_{Hi} are the plasma and cyclotron ion frequencies) and for frequencies $\omega < \omega_{Hi}$, the major nonlinear mechanism is three-wave interaction. A kinetic equation for the waves is derived for the case of weak turbulence. It is found that in the region $k_\perp r_s < 1$ ($r_s = c_s/\omega_{Hi}$, where c_s is the velocity of sound) the solution is in the form of a power law. The solution may be interpreted as representing the spectrum in the region of universal equilibrium. It is shown that turbulence in this region is of a local nature. (auth)

29926 HELICON TURBULENCE SPECTRA IN COLLISIONLESS PLASMA. Livshits, M. A.; Tsytovich, V. N. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 2, 606-13(Feb 1972). (In Russian).

The effects of whistler (helicon) interaction in a collisionless plasma are calculated. It is shown that due to induced scattering by ions, evolution of the whistler vibration spectra may lead to self-trapping of the whistlers or, more precisely, to their concentration along the external magnetic field where Landau absorption vanishes. In this case a stationary turbulence spectrum expressed by a power law $W_\omega \sim 1/\sqrt{\omega}$ is formed, the exponent for ω being equal to ½. Conditions for stability of the spectrum with respect to decay processes are found: they show that the turbulence spectrum is stable if the total turbulence energy does not exceed the critical value. (auth)

29927 WAVE TRANSFORMATION IN A PLASMA WITH A NONMONOTONIC LONGITUDINAL DISTRIBUTION. Arkhipenko, V. I.; Budnikov, V. N.; Obukhov, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1512-19(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1913-23(Sep 1971).

Experiments on wave transformations in a plasma with a nonmonotonic longitudinal distribution are described. The boundaries of the absorption region were determined for various neutral pressures. The boundary agrees with the theoretical boundary for wave transformation in a one-dimensional plasma with a fixed angle α between the density gradient and the magnetic field. The transformation region is localized near a minimum in the longitudinal distribution. (auth)

29928 DISPERSION IN BEAM–PLASMA SYSTEMS: III. MAGNETIC FIELD INDUCED PRESSURE ANISOTROPIES. Verheest, Frank (Rijksuniversiteit, Ghent). Beitr. Plasmaphys.; 11: No. 5, 375-82(1971).

A treatment is given of linear waves in a homogeneous beam–plasma system in the presence of an external magnetic field. The pressure anisotropies generated by the magnetic field are also taken into account. The most general dispersion formula is then derived, using a low-temperature closure condition. The result is a coupling between all plasma waves, due to three causes: the external magnetic field, the pressure anisotropies, and the beam velocities. Each of these phenomena can cause a coupling. Taken together, the coupling is intricate and complete. The only simplification comes from wave vectors parallel to the zero-order magnetic field; then the waves are modified longitudinal and transverse waves. (auth)

29929 GLOBAL SOLUTIONS OF THE GENERALIZED KORTEWEG–DE VRIES EQUATION. Tsutsumi, Masayoshi (Waseda Univ., Tokyo). Publ. Res. Inst. Math. Sci.; 7: No. 2, 329-44(Nov 1971).

An initial-boundary-value problem is investigated for the generalized Korteweg–de Vries equation. Two theorems for the boundary conditions are proven. (M.O.W.)

29930 PLASMA OPACITY REMOVED. Demchenko, V. V.; Hussein, A. M. (Atomic Energy Establishment, Cairo). Phys. Lett.; 39A: No. 1, 61-2(10 Apr 1972).

It was demonstrated that the allowance made for strict nonlinearity results in the penetration of the electromagnetic field into "opaque" plasma embedded into a magnetic field. (auth)

29931 STRUCTURE OF EXTREMELY STRONG SHOCK WAVES IN WEAKLY IONIZED GASES. Netto, Demetrio Bastos. Ann Arbor, Mich.; Univ. of Michigan (1971). 169p. University Microfilms Order No. 72-4823.

Thesis.

Special attention is given to the electrostatic field, which is induced because of the existing charge-separation effect inside the shock region. A first order nonlinear ordinary differential equation is obtained for the electric field in the shock transition. This equation is solved analytically for the case when the electron–neutral and the ion–neutral mean free paths downstream of the shock region are equal. A numerical result for the general case is also included. An approximate analysis is made on the behavior of an electromagnetic field applied transverse to the flow in the far upstream of the shock front. The approximations involved and the obtained results are discussed in the light of physical consideration. (Diss. Abstr. Int., B)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstracts 28118, 29474, 29476, 29478, and 29991.

29932 (AD-732375) EXPOSURE RATES FROM EXPERIMENTALLY FRACTIONATED FISSION PRODUCTS. Bunney, Leland R.; Sam, Daniel (Naval Ordnance Lab., White Oak, Md.). 2 Sep 1971. Contract DAHC20-70-C-0283. 15p. (NOLTR-71-154). NTIS.

Exposure rates, at three feet above a uniformly contaminated smooth plane, were calculated from recent experimentally measured gamma-ray spectra of fractionated products of thermal-neutron fission of ^{235}U. The fractionation had been carried out by very early removal of the rare gas fission products in a reproducible manner. The exposure rates were obtained at nine selected times ($\frac{1}{4}$, $\frac{1}{2}$, 1, 2, 5, 10, 24, 48 and 72 hours) after fission. The photon energies of the gamma rays released were calculated and are tabulated. (auth) (NTIS)

29933 (BNL-50306) LET OF 150-MeV PROTONS AND 70-MeV NEGATIVE π MESONS NEAR THE END OF THE PARTICLE TRACKS IN POLYETHYLENE. Tisljar-Lentulis, G. M.; Bond, V. P.; Robertson, J. S.; Moore, W. H. Jr. (Brookhaven National Lab., Upton, N. Y.). Apr 1971. Contract AT(30-1)-16. 19p. Dep. NTIS.

The spectra of energy transferred by 150-MeV protons and 70-MeV negative pions in thin scintillators were measured in the last few millimeters of the particle tracks in polyethylene. Foils of CsI(Tl) and NE 102 plastic scintillator, ranging in stopping power from 1 to 10 mg/cm^2, were used. The light yield of the foils as a function of absorbed energy was calibrated with α particles from ^{241}Am. Better results were obtained with CsI(Tl). For NE 102, distortions of the pulse-height distributions must be taken into account. They result from the nonlinear response of organic scintillators to energy deposited by heavy particles. Spectra obtained for pions are compared with those for protons, and attempts are made to interpret them in terms of LET$_\infty$. For low and medium values of LET, no striking differences in the shape of the spectra were found between pions and protons. In the channels of high energy transfers, the count rates in the pion beam exceeded those in the proton beam by 1 to 2 orders of magnitude. The largest energy transfers obtained for primary protons were about 100 keV/μm H_2O. A small contribution of counts exceeding this value is attributed to proton secondaries. In the pion spectra, the highest LET values measured exceeded 200 keV/μm H_2O. In both beams the integrated counts corresponding to low and medium values of LET were at least two orders of magnitude higher than the counts in the high LET branch of the spectra. (14 figures, 39 references) (auth)

29934 (FRNC-TH-171) SIMULATION OF THE SLOWDOWN OF ELECTRONS (<100 MeV). Savy, Claude (Toulouse Univ. (France)). 1971. 88p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The slowing-down of electrons (<100 MeV) is simulated by a Monte Carlo procedure. Blunck-Leisegang energy loss distributions, Goudsmit-Saunderson angular deflection distributions, and the Schiff bremsstrahlung differential cross section are used. Photons and their secondary electrons are also examined. In the case of semi-infinite media of Al and $C_5H_9O_2$ bombarded with a parallel electron beam, the calculations give the depth-dose curves and the energy spectra at various depths. (France)

29935 (JPRS-54992) IONIZING RADIATION IN SPACE AND SPACE FLIGHTS. Grigor'ev, Yu. G.; Efimov, V. I.; Petrov, V. M.; Kovalev, E. E. Translated from Gig. Sanit.; [36:] No. 10, 45-9(1971). 7p. NTIS.

The sources of radiation exposure during space flight are reviewed, and it is concluded that integrated doses of radiation in Soyuz 3, 4, 5, 6, 7, and 8 were several hundred times less than the permissible dose and posed no danger to the cosmonauts. Experience gained in ensuring radiation safety during brief orbital flights can undoubtedly serve as a basis for the elaboration of a radiation safety system for space flights by spacecraft of other types. (W.D.M.)

29936 (N-71-38368) RADIATIVE INTERACTIONS OF ELECTRONS WITH MATTER. Final Report. Quarles, C. A. (Texas Christian Univ., Fort Worth). Sep 1971. Contract NAS8-24658. 34p. (NASA-CR-119957). NTIS.

Experimental techniques were developed and applied to the study of inner-shell ionization by electrons, bremsstrahlung production by electrons, and electron scattering from a wide variety of targets in the energy range up to 140 keV. The equipment and research capabilities developed are described, and the results of experiments performed are presented. A list of the dissertations and publications resulting or expected from this effort is included. (auth) (STAR)

29937 (ORNL-RSIC-30(Vol.1)) ABSTRACTS OF THE DATA LIBRARY PACKAGES ASSEMBLED BY THE RADIATION SHIELDING INFORMATION CENTER. Roussin, Robert W. (Oak Ridge National Lab., Tenn.). Mar 1972. 87p. Dep. NTIS.

Data libraries are now being packaged and organized by RSIC in a manner analogous to the RSIC code collection. Each data set will carry a Data Library Collection (DLC) number and be packaged as a unit. As with the code packages, a particular data package will not remain static, but will be subject to revision, updating, and expansion as required. Such changes will be announced in the RSIC Newsletter. In radiation transport calculations, the three components of computer calculations normally take the form of (1) cross-section libraries, (2) radiation transport computer codes, and (3) radiation transport results (output). Since inception, RSIC has been deeply involved, through its computer code library, in the second component mentioned above. The data library collection has been developed such that it can include not only component (1), cross-section libraries, but also component (3), radiation transport results. In addition, data are present that allow the recalculation, with a particular calculational method, of already published results. The abstract format used for DLC's is similar to that used to describe the code packages. Care was taken to make the format include all of the information necessary for adequately describing the contents and purpose of each data library. The main purpose of the abstracts is to give to a potential data library user several criteria for deciding whether or not he wishes to obtain the data. In some cases, there may be significant gaps in the information given. The abstracts will be revised or updated as needed. (TSS) (auth)

29938 (UCRL-Trans-10586) EMISSION OF RELATIVISTIC CHARGED PARTICLES IN MAGNETIC AND ELECTRIC UNDULATORS. Korkhmazyan, N. A.; Elbakyan, C. C. Translated for Univ. of California Lawrence Livermore Lab., Livermore, from Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 6: No. 1, 7-11(1971). 7p. Dep. NTIS.

The problem of fast charged particles in motion in homogeneous static electric and magnetic fields is analyzed. It is shown that a fragmentarily homogeneous field of intensity E_0 is equivalent to a sinusoidal with amplitude $(2/\pi)E_0 \cos(\pi/2)\,(p-1)/(p+1)$, where $p = (b/a)$, a is the width of the magnetic (electric) poles, and b is the distance between the neighboring poles. Also treated is the effect of the deflection of the trajectory of the particle from the axis of the undulator in emission. (tr-auth)

29939 SHELL-WISE PHOTOELECTRIC CROSS-SECTIONS OF GAMMA RAYS. Rao, P. V. Ramana; Parthasaradhi, K. (Andhra Univ., Waltair, India). Curr. Sci. (India); 41: No. 4, 135-6(20 Feb 1972).

Total gamma-ray cross sections for lead and platinum at 100 and 280 keV were first determined on a good geometry setup by conducting transmission experiments. The total photoelectric cross sections were then obtained by subtracting the contributions due to other theoretical cross sections (Nuclear Data, 7: 565 (1970)), which are of small magnitude (4% at 100 keV and 25% at 280 keV). Finally, the shell-wise cross sections were obtained by multiplying the total by the experimental ratios reported previously by one of the authors (Nucl. Instrum. Methods, 85: 147(1970). The experimental values along with the recent theoretical shell-wise cross sections are given and show satisfactory agreement. (L.M.T.)

29940 ADJOINT DIFFERENCE METHOD AND ITS APPLICATION TO DEEP-PENETRATION RADIATION TRANSPORT. Hoffman, Thomas Joseph. Knoxville, Tenn.; Univ. of Tennessee (1971). 85p. University Microfilms Order No. 72-5448.

Thesis.

The problem of determining the effect of interest in a geometrically complex object (vehicle) far removed from the radiation source is important in the area of radiation transport. The direct solution to this problem involves a deep-penetration, Monte Carlo calculation. Calculations of this type are always costly, and often impossible. To deal with this problem, the adjoint-difference method was developed. This method decomposes the original problem into two independent calculations: a geometrically simple (one- or two-dimensional) deep-penetration calculation that is in-

dependent of the vehicle; and a localized, three-dimensional calculation that is independent of the radiation source. The first calculation is suitable to deterministic methods of solution, such as discrete ordinates. The second, by nature of the geometry, must be solved by Monte Carlo techniques; however, this is not a deep-penetration calculation. Therefore, the dual complexity of geometry and statistics inherent in a deep-penetration Monte Carlo calculation is avoided. Since the above calculations are independent, only the coupling of these calculations depends on the relative position and orientation of the source and vehicle. With this property, a great deal of information can be obtained from a single Monte Carlo calculation. The method was examined through application to several problems. All results were compared to those obtained from presently acceptable methods of problem solution. In all cases, the adjoint difference method was shown to be an efficient, versatile method of calculation. (Diss. Abstr. Int., B)

29941 BUILDUP FACTOR IN DETECTION OF γ TRACERS IN PIPES. Munteanu, G. (Polytechnic Inst., Brasov, Rumania). Stud. Cercet. Fiz.; 23: No. 8, 871-5(1971). (In Rumanian).

Some aspects of the detection of γ tracers in pipes and the necessity to use the buildup factor, which describes the multiple diffusion of γ rays, are discussed. The results at the detection of the γ-cylindrical homogeneous source are presented. These results lead to an expression for the buildup factor of the punctiform source in the γ-cylindrical homogeneous radioactive medium. (auth)

29942 ABSOLUTE CROSS SECTIONS FOR THE ELEMENTARY PROCESS OF BREMSSTRAHLUNG PRODUCTION. Aehlig, A.; Scheer, M. (Univ., Wuerzburg, Ger.). Z. Phys.; 250: No. 3, 235-47(1972). (In German).

Bremsstrahlung cross sections differential in electron angle, photon angle, and energy were determined for silver. The energy of the incident electrons was 180 keV and the scattered electrons 100 keV. Within the experimental errors, agreement with the results of the calculations of Elwert and Haug (Phys. Rev., 183: 90(1969)) was found. (tr-auth)

29943 FIRST RESULTS OF THE DETERMINATION OF DOSE DISTRIBUTION OF TANGENTIAL STATIONARY FIELDS EMPLOYING A DIGITAL COMPUTER. Heilmann, H. P.; Schroeder, U. G. (Univ., Tuebingen, Ger.). Fortschr. Geb. Roentgenstr. Nuklearmed.; 114: No. 6, 839-43(1971). (In German).

The isodoses of the tangential telecobalt stationary fields are plotted on the basis of ionometric dosage measurements with wedge filters within the point matrix of a special plexiglas–water phantom. A CDC-3300 computer with a special interpolation program in FORTRAN IV is used for this purpose. This procedure makes it possible to calculate the summation isodoses from opposing-beam tangential fields and to study the influence of various beam angles or, as the case may be, field intervals on dosage distribution. (INIS)

29944 RADIATION DOSE TO MAN FROM GALACTIC COSMIC RAYS. O'Brien, Keran; McLaughlin, James E. (Atomic Energy Commission, New York). Health Phys.; 22: No. 3, 225-32(Mar 1972).

The dose and dose equivalent rates to man in the Earth's atmosphere were calculated for geomagnetic latitudes of 43 and 55°, at solar minimum and maximum as a function of elevation in the Earth's atmosphere. These calculations were based on a theory of radiation transport shown to yield correct values for cosmic-ray ionization and fluxes measured near these latitudes. Depth–dose and dose-equivalent curves are given. Atmospheric profiles of the dose and dose equivalent rate evaluated at a depth of 5 cm in tissue are presented. (auth)

29945 MEDICAL ASPECTS OF SUPERSONIC TRAVEL. Preston, F. S. (Air Corporation Joint Medical Service, London). Proc. Roy. Soc. Med.; 65: No. 2, 187-92(Feb 1972).

The following problems considered by the Concorde Aeromedical Group are briefly discussed: high altitude radiation exposure, thermal environment, noise, and environment. Radiation hazards are from galactic and solar radiation. An aircraft-borne warning system for immediate descent away from flares is mentioned. Aircrew and passenger exposures are briefly discussed in relation to ICRP recommendations for radiation workers and the general public. (UK)

29946 COMPARISON OF STOPPING POWERS OF Al, Ni, Cu, Rh, Ag, Pt, AND Au FOR PROTONS AND DEUTERONS OF EXACTLY THE SAME VELOCITY. Ishiwari, Ryutaro (Nara Women's Univ., Japan); Shiomi, Naoko; Shirai, Shigeko; Ohata, Tokiko; Uemura, Yoshiaki. Bull. Inst. Chem. Res., Kyoto Univ.; 49: No. 6, 390-402(Nov 1971).

Stopping powers of Al, Ni, Cu, Rh, Ag, Pt and Au for protons and deuterons of exactly the same velocity, of which the approximate energies are 7.2 and 14.4 MeV, were measured and compared to each other. The stopping powers for protons obtained in the present experiment were found to be lower than the experimental results of Andersen et al. by 1 to 2.5%. It was found that the stopping power for deuterons is significantly higher than that for protons of exactly the same velocity. The deviations are from 1 to 2.5%. (auth)

29947 STOPPING POWER OF Be, Al, Cu, Mo, Ta, AND Au FOR 28 MeV ALPHA PARTICLES. Ishiwari, Ryutaro (Nara Women's Univ., Japan); Shiomi, Naoko; Shirai, Shigeko; Ohata, Tokiko; Uemura, Yoshiaki. Bull. Inst. Chem. Res., Kyoto Univ.; 49: No. 6, 403-8(Nov 1971).

The stopping power of Be, Al, Cu, Mo, Ta and Au for 28-MeV alpha particles was measured with a silicon detector and associated electronic equipment. It was observed that the stopping power for alpha particles divided by 4 is higher than for protons of the same velocity. The deviations are about 1.5 to 3%. (auth)

29948 TOTAL L-SHELL PHOTOELECTRIC CROSS SECTIONS OF GAMMA RAYS. Seshagirirao, V.; Parthasaradhi, K. (Andhra Univ., Waltair, India). Indian Mining Eng. J.; 8: No. 2, 47(1969).

Data on total L-shell cross sections at low gamma energies with a discussion in the light of theoretical data are reported. Total L-shell photoelectric cross sections are determined at gamma energies below the K edge in U, Pb, Au, W, and Sn by subtracting the other theoretical and subshell cross sections from the total experimental gamma ray cross sections (Appl. Phys. J., 36: 1681(1966); Phys. Rev., 153: 307(1967)). (Ind. Sci. Abstr.)

29949 DISTRIBUTION FUNCTION OF ISOTROPICALLY SCATTERED PARTICLES IN ANISOTROPIC STRUCTURES. Dolgov, A. S. Zh. Prikl. Mekh. Tekh. Fiz.; No. 5, 46-50 (Sep-Oct 1971). (In Russian).

The properties of the solutions of a single-velocity equation of particle transport in a medium were studied with the dependence of the probabilities of elementary processes for spherical scattering indices. The linear parameter of exponential asymptotic attenuation of the global density of particles for media with oriented nonhomogeneity may be very well differentiated from analogous quantities found by averaging the probabilities of elementary processes according to directions. The role of special features of oriented nonhomogeneity was examined. Generalizations were made on anisotropic scattering. (tr-auth)

29950 TWO-GROUP TRANSPORT EQUATION WITH A SEPARABLE KERNEL. Silvennoinen, Pekka; Zwiefel, P. F. (Virginia Polytechnic Inst. and State Univ., Blacksburg). Transp. Theory Statist. Phys.; 1: No. 3, 239-60(1971).

A two-group transport equation with a separable kernel is studied in the constant cross-section limit. Eigenfunctions and eigenvalues are derived, and full-range orthogonality proved (in an appendix, normalization integrals are derived). Then, certain completeness theorems are proved, namely: (1) if the transport equation reduces to a Hilbert problem involving continuous coefficients the eigenfunctions are complete on the full range; (2) if, in addition, the dispersion matrix $\underline{\beta}(z)$ is even, the eigenfunctions are also complete on the half range (this occurs, for example, if $\underline{\zeta}(\mu',\mu) = \underline{\zeta}(-\mu',-\mu)$, which is a physically meaningful case); (3) if the transport equation reduces to a Hilbert problem with discontinuous coefficients, then nothing can be said a priori about full-range completeness, but a procedure is developed, using certain theorems of Vekua, for determining the sign of an index ρ; the sign of ρ determines the existence of a full-range expansion; and (4) if the transformation matrix of the Hilbert problem obeys the Lipschitz condition, then full-range completeness implies half-range completeness, and vice versa. (This stringent condition is not necessary in the case of continuous coefficients). Throughout the work, certain reasonable assumptions are made, for example, that the functions being expanded obey an extended Hoelder condition. In an appendix a scalar singular integral equation is obtained, which may be solved by analytical or numerical methods as necessary. This equation, which has quite similar form for the full- and half-range cases, contains a Fredholm term which is, in general, nondegenerate. It is curious that while no techniques are known for solving such equations, a solution can be obtained, at least in the full-range case, from orthogonality. Finally, in another appendix, a classification of types of transport problems is given in terms of the so-called "g-matrix". (auth)

29951 APPLICATION OF NOETHER'S THEOREM TO THE TRANSPORT EQUATION. Tavel, M. (Vassar Coll., Poughkeepsie, N. Y.). Transp. Theory Statist. Phys.; 1: No. 4, 271-85(1971).

The Euler–Lagrange equations are derived for a variational integral whose integrand is a function of the integral as well as

differential operations on the field functions. An analog of Noether's theorem is then derived for the same integral. Using the derived Euler–Lagrange equations, a Lagrangian density is constructed that yields the single-speed, one-dimensional transport equation and its adjoint. The Lagrangian density is found to be invariant under a gauge group, and Noether's theorem is then used to derive a conserved current as a consequence of this invariance. (auth)

29952 MULTIGROUP TRANSPORT EQUATION WITH A DEGENERATE KERNEL. Silvennoinen, Pekka (Virginia Polytechnic Inst. and State Univ., Blacksburg). Transp. Theory Statist. Phys.; 1: No. 4, 263-70(1971).

A multigroup transport equation with a degenerate kernel for anisotropic scattering is considered, assuming a constant total cross section. Eigenfunctions are constructed and their completeness properties are established by extending the earlier treatments of less-complicated kernels. While analytic solutions to infinite-medium problems are, in principle, available, no explicit solutions are presented. (auth)

29953 CALCULATION OF MAGNETO-BREMSSTRAHLUNG EMITTED BY BUNDLES OF ELECTRONS. Snedkov, B. A.; Mel'nichuk, V. G. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 16: No. 6, 1007-10(Jun 1971).

Translated from Radiotekh. Electron.; 16: No. 6, 1024-7(Jun 1971).

A method of calculation of radiation intensity in a magnetic field based on works of classical electrodynamics and analysis of the parameters of low-energy electron bunches in klystron-type bunchers is proposed. The effect of space charge, the repetition rate of electron bundles and nonuniformity of the magnetic field on the blurring of the spectral lines and intensity of oscillations are taken into account. It is shown that when a number of conditions are satisfied, intensity of oscillations is close to coherent radiation. (auth)

29954 CHARACTERISTIC SCATTERING OF SLOW ELECTRONS FROM Ni(111) AND ITS TEMPERATURE DEPENDENCE IN THE AREA OF THE FERROMAGNETIC CURIE POINT. Heimann, B.; Hoelzl, J. (Technische Univ., Clausthal, Ger.). Z. Naturforsch.; 27a: No. 3, 408-19(Mar 1972). (In German).

Characteristic energy losses (CEL) of slow electrons scattered from a Ni(111) surface were studied, using primary energies E_p in the range $150 \leq E_p \leq 600$ eV. Special attention was given to the cleanliness of the crystal surface. In particular, CEL were studied as function of temperature T in the range containing the Curie temperature T_c. The volume loss energy $\hbar\omega_p$ shows an anomalous variation in the region of T_c superimposed on a linear decrease from T = 100 to 700°C, while the surface loss energy $\hbar\omega_s$ remains constant in this range within the error of measurement (±0.1 eV); $\hbar\omega_p$ and $\hbar\omega_s$ could be identified in connection with optical measurements of Vehse and Arakawa (Phys. Rev., 180: 695(1969)). A possible explanation of the variation of loss energy $\hbar\omega_p$ is given in terms of electronic band structure changes. (39 references). (auth)

29955 PAIR PRODUCTION PROCESS IN Pt-Rh ALLOY. Ramarao, J.; Reddy, D. K. S.; Lakshmanarao, A.; Parthasaradhi, K. (Andhra Univ., Waltair, India). Indian Mining Eng. J.; 8: No. 2, 59; 61(1969).

Pair production cross sections in Pt–Rh alloy were determined in the energy region 1 to 2 MeV utilizing the experimental cross sections in Pt and Rh and employing the theoretical sum rule. These values are found to be in agreement with the cross sections determined directly in the alloy, thus providing the validity of the sum rule. The effective atomic numbers in Pt–Rh alloy determined from these values are found to be in satisfactory agreement with the predictions of Hine. (Ind. Sci. Abstr.)

29956 RETARDATION OF PROTONS IN CHROMIUM AND COPPER. Abroyan, I. A.; Koryukin, V. A. (Leningrad Polytechnic Inst.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 10, 10, 2614-16(Apr 1972).

Translated from Fiz. Tverd. Tela; 13: No. 10, 3112-14(Oct 1971).

Energy losses of protons in Cr and Cu at 0 to 10 keV were investigated using surface-barrier diodes formed by deposition of Cr and Cu onto Si and GaAs crystals. The energy loss $\Delta E/d$ was derived from the number of electron–hole pairs measured in the diodes. For Cr, $-\Delta E/d = 5 \times 10^{-15} E^{0.45}$ eV·cm²/atom and the maximum free path $R = 330 \times 10^{15} E^{0.57}$ atoms/cm². For Cu, $-\Delta E/d = 4 \times 10^{-15} E^{0.46}$ eV·cm²/atom and $R = 420 \times 10^{15} E^{0.55}$ atoms/cm². (D.L.C.)

29957 ELECTRON ENERGY LOSS IN ALLOYS OF ALUMINUM WITH 3d TRANSITION METALS. Bakulin, E. A.; Bredov, M. M.; Vasil'ev, V. A. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 10, 2536-40(Apr 1972).

Translated from Fiz. Tverd. Tela; 13: No. 10, 3026-31(Oct 1971).

Energy-loss spectra of electrons having an initial energy of 20 keV that pass through thin films of Ti, V, Co, Ni, and alloys of these metals with Al were studied. The thin films were produced by metal-vapor deposition on the polished surface of rock salt at 2×10^{-8} torr. The concentration dependence found for the primary energy loss is discussed. For Co and Ni, there is a discussion of the difference between the experimental energy loss and the loss calculated from the theory of a free electron gas. (auth)

29958 DYNAMICAL THEORY OF THE INTERACTION OF RADIATION WITH A SLIGHTLY DISTORTED CRYSTAL UNDER STRONG-ABSORPTION CONDITIONS. Kon, V. G. Sov. Phys.-Solid State (Engl. Transl.); 13: No. 10, 2495-250(Apr 1972).

Translated from Fiz. Tverd. Tela; 13: No. 10, 2974-81(Oct 1971).

A dynamical theory is derived for the interaction of radiation with a distorted crystal for the case in which effects associated with absorption of the radiation are important. For the case of slight crystal distortion, the problem is reduced to that of solving a one-dimensional Volterra integral equation. The effect of slight distortion on the suppression of inelastic nuclear-reaction channels is analyzed. It is shown that the intensity of radiation passing through a distorting crystal can be described well by means of an integral anomalous-absorption coefficient. (auth)

29959 CHARGED-PARTICLE ENERGY LOSS TO ELECTRON GAS. Pathak, A. P.; Yussouff, M. (Indian Inst. of Tech., Kanpur). Phys. Status Solidi (b); 49: No. 2, 431-41(1 Feb 1972).

The contribution of the conduction electrons to the stopping power $(-dE/dx)$ of fast charged particles in a crystal was calculated using different forms of the dielectric function. The various approximate forms of dielectric functions used are: (1) random phase approximation (RPA), (2) Hubbard approximation (both screened and unscreened), (3) Kleinman approximation, and (4) the dielectric function obtained by variational calculation of Langreth. The intermediate velocity range for the incident particles, namely $2\,V_F < V < 10\,V_F$, was investigated and it was found that in this region the stopping power varies inversely with the particle velocity. Moreover, the velocity dependence is found to be insensitive to the form of the dielectric function used in the calculation. (auth)

29960 MAGNETIC SCATTERING OF NEUTRAL PARTICLES IN POLAR MEDIA AND THE STUDY OF THE PERMITTIVITY DISPERSION IN SPACE AND TIME. Dogonadze, R. R.; Kornyshev, A. A. (Inst. of Electrochemistry, Moscow). Phys. Status Solidi (b); 49: No. 2, 453-66(1 Feb 1972).

The scattering of a compound particle by a bound system in the case of weak interaction is considered. The Born cross sections for positronium and muonium scattering by a polar nonmagnetic medium were expressed by the complex permittivity function $\epsilon_{\alpha\beta}(q,\omega)$. The possibility of an experimental study of the frequency and wave vector dependence of the permittivity of homogeneous isotropic media using data on the scattering of leptonic atoms with spin transitions is investigated. The determination of $\mathrm{Im}\{1/\epsilon^{\parallel}(q,\omega)\}$ by small-angle thermal scattering data is also discussed. (auth)

29961 GAMMA-RAY COMPTON SCATTERING: EXPERIMENTAL COMPTON PROFILES FOR He, N_2, Ar, AND Kr. Eisenberger, P.; Reed, W. A. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Rev., A; 5: No. 5, 2085-94(May 1972).

A technique is described for measuring Compton profiles using a ^{123m}Te 160-keV γ-ray source together with a Li-drifted-germanium detector. By studying He and N_2, whose Compton profiles have been previously measured using x rays and theoretically calculated, it is found that the γ-ray technique gives results that agree with both the theory and the previous x-ray measurements. Measured Compton profiles for Ar and Kr are also presented. These results would have been almost impossible to obtain by the x-ray technique because of the large photoelectric absorption of the low-energy x rays. The Ar and Kr results are compared with atomic Hartree–Fock calculations and found to agree at q = 0 within experimental error, which is less than 1%. As a result of these studies, it is concluded that all elements and their compounds can now be studied by Compton scattering. (auth)

29962 RELATION BETWEEN THE TRANSFER MATRIX METHOD AND CASE'S METHOD. Aronson, Raphael (New York Univ., N. Y.). Transp. Theory Statist. Phys.; 1: No. 3, 209-24(1971).

The relation between the Transfer Matrix for radiation transport and Case's method is elucidated. Completeness of the Case eigenfunctions is shown to be equivalent to the statement that the transfer matrix can be diagonalized. It is demonstrated that there is a one-to-one relation between the basic equations of the two methods. The implications of a symmetric scattering kernel are studied. (auth)

Radiation Protection Standards

Refer also to abstract 28046.

29963 (SZS-17/71) RADIATION PROTECTION REQUIREMENTS FOR EMERGENCY PLANNING AT NUCLEAR FACILITIES. Strauss, H.; Schimmel, W.; Koenig, W.; Albrecht, L. (Staaliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Oct 1971. 22p. (In German). Dep. NTIS (U. S. Sales Only).

From the viewpoint of radiation protection, requirements are formulated for emergency planning at nuclear facilities, taking into consideration experience gained in training, relevant Soviet documents and, above all, the recommendations given by the IAEA. On the basis of definitions and general requirements, proposals are made for emergency precautions considering both site emergencies and district emergencies. The appendix contains schematic presentations of courses of action, examples of equipment to be stored, instructions on first-aid treatment of contaminated wounds and on prophylactic application of iodine. (auth)

29964 RECOMMENDATION FOR DATA ON SHIELDING FROM IONIZING RADIATION. PART 1. SHIELDING FROM GAMMA RADIATION. METRIC UNITS. BS 4094, Part 1-1966. London; British Standards Institution (1966). 61p.

The main purpose of this recommendation is to provide data adequate for the calculation of shielding barriers against gamma radiation. Section One deals with the calculation of barriers against primary gamma radiation, and Section Two provides the data that permit the calculation to be carried out. Appendix A gives methods and data for the calculation of primary barriers in cases where insufficient data are given in Section Two. Appendix B is concerned with the calculation of the secondary barriers that are required against leakage and scattered radiation. (W.D.M.)

Radiation Source Calibration and Standardization

Refer also to abstracts 28171, 28194–28196, and 28399.

29965 GAMMA DOSE RATE AT AN EXTERNAL POINT ON THE MAJOR OR MINOR AXIS OF A SOLID RADIOACTIVE SPHEROID SOURCE. Gupta, P. C. (Inst. of Nuclear Medicine and Allied Sciences, Delhi). pp 689-700 of Basic Mechanisms in Radiation Biology and Medicine. Bombay; Dept. of Atomic Energy (1971).

From Symposium on basic mechanisms in radiation biology and medicine; New Delhi, India (11 Feb 1971). See CONF-710223.

Results have been obtained for the dose rate at an external point on the major or minor axis of a spheroidal γ source with uniform distribution of radioactivity. The variation of the dose rate as one proceeds from the surface on either axis is discussed in detail. The effect of change of shape (keeping the volume constant) on the dose rate is also presented. The results of the spheroidal source are compared with cylindrical and spherical sources of comparable geometry. (auth)

29966 PREPARING UPGD-1 CHECKING EQUIPMENT FOR CERTIFICATION. Artemov, E. L.; Garapov, E. F.; Korshikov, A. V.; Klinov, V. V. Meas. Tech. (USSR) (Engl. Transl.); 14: No. 9, 1423-6 (Sep 1971).

Translated from Izmer. Tekh.; 14: No. 9, 86-8 (Sep 1971).

The design and specification of collimated standard gamma sources for calibrating dosimetric instruments and for calibrating gamma sources are presented. (W.H.D.)

29967 INTEGRAL SIGNAL METHODS FOR DETERMINATION OF DOSE EQUIVALENT. Zielczynski, M. pp 60-74 of Radiation Dosimetry. Vol. 2. /Miric, I. (ed.). Belgrade; Boris Kidric Inst. of Nuclear Sciences (1971).

From International summer school on radiation protection; Cavtat, Yugoslavia (21 Sep 1970).

The integral signal principle enables direct determination of the dose equivalent (DE) without previous analysis of radiation components. The principle is based on the use of tissue-equivalent detectors with sensitivity dependent in an appropriate way on LET. The radiation is experimentally analyzed by means of appropriate detectors, and then DE is determined by integration. Terms used in the discussion are explained, and the theory of integral signal measurements is given. Finally, concrete examples of detectors used to determine DE by the recombination method are presented. (10 figures) (R.W.R.)

29968 PRESENT STATE OF OUTPUT DOSE ACCURACY OF ^{60}Co-TELETHERAPY MACHINES IN JAPAN. Nippon Hoshasen Gijutsu Gakkai Zasshi; 26: No. 5, 9-19(Mar 1971). (In Japanese).

In 1969, there were 392 ^{60}Co-teletherapy machines in Japan, and on 151 machines of these, output dose was measured under prescribed conditions with a Victoreen 621 condenser chamber which had been correctly calibrated at National Institute for Radiological Sciences. Output dose accuracy was studied by calculating error percentage $\epsilon = (D - D_0)/D_0 \times 100$, where D is dose rate adopted at each hospital, D_0 is the dose rate measured with the Victoreen 621 chamber. The average error percentage of 151 machines was -0.28%, and it showed that measurement of the output dose in Japan had been exceedingly correct. But, standard deviation of this error percentage was $\pm 11.42\%$, and it seemed rather large. Machines having the error percentage above $\pm 20\%$ were 13 (about 8.5%), those above $\pm 30\%$ were 5 (about 3%), and that above $+40\%$ was 1. Machines containing source above 1000 Ci showed smaller standard deviation than those below 1000 Ci, and in hospitals having foreign made dosimeters, this standard deviation was smaller than in those having Japanese made dosimeters. However, there was no correlation between these two examinations. When regional differences were studied, this standard deviation in Tohoku district was large in comparison with that in other districts. (Japan)

Shielding Calculations and Theory

Refer also to abstracts 28743, 29142, and 29937.

29969 (AEC-tr-7175) RADIATION TRANSMISSION THROUGH INHOMOGENEITIES IN SHIELDS. Zolotukhin, V. G.; Klimanov, V. A.; Leipunskii, O. I.; Mashkovich, V. P.; Sakharov, V. K.; Sinitsyn, B. I.; Tsypin, S. G. Translation of Prokhozhdenie izluchenii cherez neodnorodnosti v zashchite, Atomizdat, Moscow, 1968. 368p. (TT-70-50155; IPST-Cat,-5846). Dep. NTIS.

Basic definitions and classifications of the inhomogeneities occurring in shields, basic data on shielding constants for calculations, and details of calculation methods and experimental techniques for investigating radiation fields in shields containing inhomogeneities are presented. Material is included on the passage of radiation through the main types of commonly occurring inhomogeneities—empty or filled straight ducts, passing completely or partially through the shield; sectionalized bent ducts; and uniaxial and multiaxial, stepped ducts—and through shields containing distributed voids or inclusions. The perturbation introduced by linear inhomogeneities into a distributed radiation field in a medium is estimated. The general approach to the solution of problems is to divide the overall characteristic of a radiation field (flux density, intensity, dose rate, etc.) into separate components. (M.H.R.)

29970 (COO-2060-16) APPLICATIONS OF THE TRANSMISSION MATRIX TO RADIATION SHIELDING. Final Report. Rohach, Alfred F. (Iowa State Univ. of Science and Technology, Ames. Engineering Research Inst.). Feb 1972. Contract AT(11-1)-2060. 124p. Dep. NTIS.

The purpose of the analysis was to investigate the possibilities of developing a point kernel from the transmission-matrix method as it was developed for plane geometry. Transmission of gamma radiation through plane multilayered geometry was investigated for point isotropic sources. Investigations also were made into applications of the point kernel for certain standard geometry sources in a homogeneous medium. These applications included integrating the point kernel over these sources. As a result of the investigations, a computer code was developed that could perform the necessary operations in the transmission-matrix method effectively and efficiently. The code operates in a series of four steps, the first three being used only once for a particular material with a fixed-energy group structure and angular expansion. The fourth step is the shielding step, where the shielding design calculations are performed. The details of the computer code are discussed. (auth)

29971 (JEN-219-DQ/I-78) ELEMENTARY COMPUTATION OF RADIATION DOSES AND SHIELDINGS FOR RADIOCHEMICAL LABORATORIES. Jimeno de Osso, F. (Junta de Energia Nu-

clear, Madrid (Spain). Division de Quimica). 1971. 60p. (In Spanish). Dep. NTIS (U. S. Sales Only).

Simple procedures for the calculation of radiation exposure, half-thickness, shield thickness, etc. are described and equations and graphs are included for those gamma-emitting radionuclides, that are more often used in radiochemical laboratories. Application is made of these procedures to three radionuclides, bromine-82, sodium-24, and cobalt-60, which cover a rather wide energy range; theoretical results are compared with those obtained from experimental measurements. Finally, a brief survey is made of the problems set forth by beta particles, and equations for the calculation of range, equivalent dose, etc. are given; they are applied to the case of phosphorus-32 and the theoretical and experimental results are compared. (auth)

29972 (JUL-794-PC) SHIELDING OF THE FAST NEUTRONS FROM NEUTRON GENERATORS. Sauermann, P. F. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Physikalische Chemie). Sep 1971. 32p. (In German). Dep. NTIS (U. S. Sales Only).

Attenuation factors are calculated for shielding of neutron generators by means of water, as well as by a great number of ordinary concretes and heavy concretes. Moreover, the shielding is considered for two-layer shieldings consisting of iron and water, as well as iron and concrete. From an example in the field of health physics, the effect of one-layer shieldings in contrast to two-layer shieldings is considered. (auth)

29973 (JUL-800-RX) TABLES OF ACTIVATION AND SHIELDING OF THE RADIONUCLIDES FORMED THEREBY. Sekkal, M.; Graudus, E. (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Reaktorexperimente). Oct 1971. 109p. (In German). Dep. NTIS (U. S. Sales Only).

Tabulated are activation data furnished by literature as well as shielding data according to Rockwell and ANL 5800. The tables permit determination of both specific activities (curies/g) and dose rates (millirem/hour) of nonshielded sources, as well as the thickness of required shielding. Use of the tables is explained and practical examples are given. A special chapter is devoted to the activation of cooling circuits. (H.B.G.)

29974 (N-72-12598) APPLICATION OF THE METHOD OF STEEPEST DESCENT TO LAMINATED SHIELD WEIGHT OPTIMIZATION WITH SEVERAL CONSTRAINTS: THEORY. Lahti, Gerald P. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov 1971. 20p. (NASA-TM-X-2435; E-6542). NTIS.

The method of steepest descent used in optimizing one-dimensional layered radiation shields is extended to multidimensional, multiconstraint situations. The multidimensional optimization algorithm and equations are developed for the case of a dose constraint in any one direction being dependent only on the shield thicknesses in that direction and independent of shield thicknesses in other directions. Expressions are derived for one-, two-, and three-dimensional cases (one, two, and three constraints). The procedure is applicable to the optimization of shields where there are different dose constraints and layering arrangements in the principal directions. (auth) (STAR)

29975 (ORNL-TM-3517) NEUTRON AND GAMMA-RAY FLUENCE TRANSMITTED THROUGH A SLAB OF BORATED POLYETHYLENE: A MILESTONE CALCULATION. Burgart, C. E. (Oak Ridge National Lab., Tenn.). 22 Mar 1972. 27p. Dep. NTIS.

A multigroup Monte Carlo code, a two-dimensional discrete ordinates code, and a one-dimensional discrete ordinates code were utilized in a milestone radiation transport calculation. The neutron energy spectrum and the neutron and gamma-ray fluence at points located a large distance from a slab of borated polyethylene were calculated. A line beam of neutrons with a ^{235}U fission spectrum is assumed normally incident on the slab. Identical multigroup cross sections were employed, thus providing a rigorous comparison of the transport methods alone. A pseudo-energy point cross-section Monte Carlo code was also utilized. This provided a check on the cross-section processing codes. The methods yield nearly identical results for points located within 30° of a normal to the slab. The agreement becomes less satisfactory at greater angles. However, possible explanations for the observed discrepancies are given. (auth)

29976 (PEL-213) PELSHIE: A GENERAL PURPOSE SHIELDING PROGRAM FOR POINT AND EXTENDED GAMMA-RAY SOURCES. de Beer, G. P. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Oct 1971. 79p. Dep. NTIS (U. S. Sales Only).

A computer program, PELSHIE, written in FORTRAN IV and which calculates shield thicknesses for gamma-ray sources of various geometries, is described. The program has direct access to a magnetic disc data library containing emission characteristics as well as attenuation and buildup coefficients for a variety of gamma-emitting isotopes and shielding materials, respectively. (auth)

29977 BACKSCATTERING ABSORBER MATERIALS FOR GAMMA RAYS. Kato, Masao; Tanaka, Goro; Yamamoto, Seigoro (to Giken Kogyo Kabushiki Kaisha). U. S. Patent 3,644,736. 22 Feb 1972. Filed 5 Nov 1968.

Backscattering absorber materials for γ rays are described, comprising a mixture consisting of 70 to 90% by weight of lead compound, 10 to 20% by weight of barium compound and 3 to 10% by weight of iron compound, and a vehicle. In one type of embodiment, polyvinyl alcohol in 25% aqueous solution of 28 to 39% by weight of said mixture is used as the vehicle. In another type of embodiment, the vehicle is a mixture comprising 30 parts of vinyl acetate as a film-forming agent, 0.2 part of methyl cellulose dissolved in 10 parts of water as a thickening agent, and 4 parts of ammonium salt of vinyl acetate copolymers in 25% solution as a dispersing and wetting agent, and said vehicle mixture being 25 to 67% by weight of the first principal mixture. Regardless of the type of vehicle, the backscattering absorption characteristics of the absorber materials are substantially invariant, so far as the composition of the first said principal mixture is kept constant. (auth)

29978 EXAMINATION OF SYNCHRONOUS SHIELDING IN ^{60}Co ROTATIONAL THERAPY. Rawlinson, J. A.; Cunningham, J. R. (Ontario Cancer Inst., Toronto). Radiology; 102: No. 3, 667-71(Mar 1972).

The behavior of the dosage distributions produced by synchronous shielding techniques is examined. Shielding of sensitive structures is obtained only at the expense of dose uniformity in the high-dose region. Uniformity can be improved only by shaping the open part of the beam with specially constructed wedge filters. (auth)

PHYSICS (SOLID-STATE)

Radiation Effects

Refer also to abstracts 27925, 28150, 28151, 29457, 30136.

29979 (COO-3158-1) DIRECT OBSERVATION OF GRAIN BOUNDARY DISLOCATION CLIMB IN ION IRRADIATED GOLD BICRYSTALS. Komem, Y.; Petroff, P.; Balluffi, R. W. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). 21 Dec 1971. Contract AT(11-1)-3158. 25p. Dep. NTIS.

Thin-film gold bicrystals containing (001) low-angle twist boundaries, with twist angles in the range $\theta = 7 - 14°$, and high-angle twist boundaries, with $\theta \simeq 37°$, were prepared by welding evaporated films together face-to-face. All the boundaries contained regular orthogonal arrays of intrinsic-screw grain-boundary dislocations (GBD's) as well as more randomly occurring extrinsic-edge GBD's having Burgers vectors essentially perpendicular to the boundary. The specimens were irradiated on one face with 20-keV gold ions producing excess self-interstitial atoms which diffused to the extrinsic GBD's causing them to climb in the boundary. The extrinsic GBD climb, in turn, caused the boundaries to act as overall interstitial sinks. The climb motion was observed directly by transmission electron microscopy. The intrinsic-screw GBD's in the high-angle boundaries (and probably also in the low angle boundaries) remained unaffected during the process, but possibly they acted as short circuiting pipes which delivered interstitials to the extrinsic GBD's. It is concluded generally that both low- and high-angle boundaries may act as point-defect sinks (sources) by means of the climb of GBD's having Burgers vectors with components normal to the boundary plane. This process is actually a form of internal crystal growth (dissolution) with the GBD's acting as "internal crystal ledges". (auth)

29980 (N-71-38237) EFFECT OF 1.5-MeV ELECTRON IRRADIATION ON THE TRANSMISSION OF OPTICAL MATERIALS. Interim Summary Technical Report, September 16, 1970-September 15, 1971. Palma, Gary E.; Gagosz, Ronald M. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1971. Contract SNPC-70. 49p. (NASA-CR-123187; ITR-2; K-990929-2). NTIS.

A program of experiments was conducted to measure the optical transmission of several transparent materials before, during, and immediately after 1.5-MeV electron irradiation. A comparison was made of irradiation-induced optical absorption in three commercial grades of high-purity fused silica. It was found that the behavior of Corning 7940, Amersil, and Spectrosil high-purity grades of fused silica were similar with regard to the generation, annealing, and optical bleaching of the irradiation-induced optical absorption in the wavelength interval 2000 to 3000 Å. In addition, measurements of the optical transmission of single-crystal specimens of aluminum oxide, magnesium fluoride, barium fluoride, lithium fluoride, and beryllium oxide were made during 1.5-MeV electron irradiation in the wavelength interval of 2000 to 3000 Å. (auth) (STAR)

29981 EFFECT OF CHANNELING ON THE LATTICE DEFECTS PRODUCED BY PROTON IRRADIATION IN ALKALI HALIDE CRYSTALS. Ozawa, K (Japan Atomic Energy Research Inst., Tokai); Fujimoto, F.; Komaki, K.; Mannami, M.; Sakurai, T. Phys. Status Solidi (a); 9: No. 1, 323-32(16 Jan 1972).

The effects of radiation damage due to the proton bombardment on the channeling phenomena in KCl, NaCl, KI, LiF, and NaF were studied using the backscattering technique. The growth curves always showed sublinear relations with proton dose. For KCl and NaCl, the temperature dependence of formation of the defects and the channeling effects in the ⟨100⟩ and ⟨110⟩ axes were investigated. The results showed that the recovery rate at high temperature was larger than that at low temperature and the body-centered interstitial defects in the sublattice were dominant in NaCl and face-centered defects in addition to body-centered ones existed in KCl. (auth)

29982 EFFECTS OF γ-RAY IRRADIATION ON PHOTOCONDUCTION OF POLYETHYLENE (PE). Mizutani, Teruyoshi; Takai, Yoshiaki; Ieda, Masayuki (Nagoya Univ., Japan). Jap. J. Appl. Phys.; 11: No. 3, 411(Mar 1972).

Films of polyethylene about 20 μm in thickness were irradiated in air by gamma rays from ^{60}Co. Typical dark- and photo-currents of γ-irradiated (γ-PE) and nonirradiated (n-PE) polyethylene are tabulated. The photocurrent of n-PE was induced mainly by ultraviolet light, while that of γ-PE was induced by visible and near-infrared light as well. This change suggests the introduction of donors and traps distributed in a wide energy range. The effect of air pressure on the photocurrent is shown. (R.W.R.)

29983 PRE-EXPONENTIAL FACTOR IN ELECTRICAL CONDUCTIVITY OF IRRADIATED POLYETHYLENE. Sawa, Goro (Nagoya Univ., Japan); Kitagawa, Keiichi; Ieda, Masayuki. Jap. J. Appl. Phys.; 11: No. 3, 416-17(Mar 1972).

In the temperature range well below the melting point, the conductivity of a sample of annealed polyethylene can be expressed by the formula $\sigma = \sigma_0 \exp(-U/kT)$, where σ_0 is constant, k is Boltzmann's constant, T is the absolute temperature, and U is the apparent activation energy. Exposure to gamma radiation changes both U and σ_0. A plot of $\log \sigma_0$ vs U yields a straight line for the irradiated polyethylene, but a plot for the unirradiated sample is somewhat off this line. For the irradiated polyethylene the compensation rule, $\log \sigma_0 = \alpha + \beta U$, applies. It was found that, for polyethylene free of additives, the compensation rule holds for different radiation doses but not for zero dose. This result suggests that the predominant conduction process may be different for irradiated and unirradiated polyethylene. (R.W.R.)

29984 NEW GRADUALLY GRADED P-i-N STRUCTURE PRODUCED BY ELECTRON IRRADIATION IN GERMANIUM. I. FORMATION. Wada, Takao (Mie Univ., Tu, Japan); Fukuoka, Yutaka; Arizumi, Tetsuya. Jap. J. Appl. Phys.; 11: No. 3, 343-50(Mar 1972).

In an n-type germanium wafer 100 μm in thickness exposed to a total flux of about 10^{16} electrons/cm^2 at 8 MeV, the sign of the Hall coefficient, measured as a function of thickness of the wafer, changes from negative to positive at a distance of about 50 μ from the surface. The formation of a gradually graded p-i(high resistivity i region)-n structure can be explained fairly well by taking account of the deep energy levels associated with the defects, the condition of charge neutrality, and the range of the electrons. (15 figures, 2 tables) (auth)

29985 NEW GRADUALLY GRADED P-i-N STRUCTURE PRODUCED BY ELECTRON IRRADIATION IN GERMANIUM. II. SPACE-CHARGE-LIMITED CURRENT. Wada, Takao (Mie Univ., Tu, Japan); Fukuoka, Yutaka; Arizumi, Tetsuya. Jap. J. Appl. Phys.; 11: No. 3, 351-7(Mar 1972).

In a gradually graded p-i(high resistivity i region)-n structure with several deep recombination centers of about 2×10^{15} cm^{-3}, which are produced in a germanium slice (800 μm in thickness) by the high-energy electron irradiation, the current-voltage characteristic at a temperature below 160°K is composed of ohmic, high-injection square-law and space-charge-limited cube-law regions. Lampert and Rose's theory for the double injection into a semiconductor is satisfactorily applied to the observed current-voltage characteristics. (11 figures) (auth)

29986 ELECTRON SPECTRA EMITTED BY THE PASSAGE OF ^{60}Co γ RADIATION THROUGH A TWO-COMPONENT MEDIUM. Popova, L. V.; Chegodaeva, L. B. At. Energ. (USSR); 32: No. 1, 75-7(Jan 1972). (In Russian).

By using the Monte Carlo method and a model of γ quanta passing through matter, spectra of primary electrons formed by the γ irradiation of water as well as of the following two-component finely dispersed systems were determined: Al-H_2O, Cu-H_2O, and Pt-H_2O. A table is presented which states the percent of total electrons emitted which fall in any given 0.01 or 0.1 MeV energy interval. Such consecutive intervals run from 0.0 to 1.25 MeV, and the largest number of Compton electrons is seen to possess energies below 0.1 MeV. The number of electrons evoked by one γ quantum was 15, 11 to 12, 6 to 7, and 3 for H_2O, Al-H_2O, Cu-H_2O, and Pt-H_2O, respectively. (2 tables) (K.S.W.)

29987 MAGNETIC PROPERTIES OF URANIUM CARBIDES AFTER NEUTRON IRRADIATION. Matsui, Hisayuki (Nagoya Univ., Japan). J. Nucl. Sci. Technol. (Tokyo); 9: No. 3, 185-6 (Mar 1972).

The magnetic susceptibility of uranium carbides was studied before and after neutron irradiation. From the results it was found that UC exhibited anomalous behavior in its magnetic property on post-irradiation annealing. A similar anomalous susceptibility was also observed in post-irradiation annealing of UC_2. The susceptibility of pre-irradiated uranium sesquicarbide, U_2C_3, obeyed the Curie-Weiss law above 77°K. (P.C.H.)

29988 TEMPERATURE OF THERMAL PEAKS DURING IRRADIATION OF IONIC CRYSTALS. Eremin, L. P.; Oblivantsev, A. N. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 3, 149-51(1971). (In Russian).

The effects of temperature on the decomposition of polycrystalline samples of $NaNO_3$ during irradiation with 5-MeV protons and

20-MeV α particles were studied. In the ln G vs 1/T graph, two regions were noted that differed in their energies of activation. The common boundary of these two regions was 324°K for protons and 345°K for α particles. (K.S.W.)

29989 CORRELATION OF HEAVY-ION IRRADIATION DATA FOR SILICON AND GALLIUM ARSENIDE. Pritchard, W. M. (Old Dominion Univ., Norfolk, Va.). Nucl. Sci. Eng.; 47: No. 4, 470-1(Apr 1972).

Empirical equations were obtained for the surface damage resulting from heavy ion irradiation of silicon and gallium arsenide single crystals in terms of the incident ion fluence. The parameters in these equations were found to depend only on ion speed and not on ion species for a given initial ion energy and a particular semiconductor material. (auth)

29990 COMPUTER EVALUATION OF NUCLEATION OF VOIDS IN IRRADIATED METALS. Powell, Roger W.; Russell, Kenneth C. (Massachusetts Inst. of Tech., Cambridge). Radiat. Eff.; 12: No. 1-2, 127-31(Jan 1972).

A computer evaluation of a theory for coprecipitation of vacancies and solvent interstitials into voids is presented. Increasing the impingement frequency of interstitials (to up to 0.999 that of vacancies) severely curtails the nucleation process, by both elevating and widening the activation barrier. The critical nucleus size may be increased by several orders of magnitude, which in turn increases the incubation time so much that nucleation is suppressed for long periods of time, even though the steady-state rate is very great. The presence of interstitials has only a modest effect on the steady-state nucleation rate. Even at interstitial concentrations that have increased the critical size by orders of magnitude, the steady-state rate (usually exponential in critical nucleus size) is depressed by only a few powers of ten. (auth)

29991 ROLE OF ELECTRON SHELLS IN KINETIC ELECTRON EMISSION AND LUMINESCENCE UNDER ION BOMBARDMENT. Baklitskii, B. E.; Parilis, E. S. (Inst. for Electronics, Tashkent). Radiat. Eff.; 12: No. 1-2, 137-5(Jan 1972).

The method of Slater wave functions was used for obtaining a general formula for inelastic losses during the passage of ions along single-crystal channels and also for clarifying the influence of the atom shell structure on such phenomena as ion electron emission or luminescence under ion bombardment of poly- and single crystals. With increasing atomic number and the subsequent filling of the outermost shell the size of the atom is reduced, which minimizes the inelastic energy transmitted during collisions. A competing process is the growing number of electrons in the outermost shell, and the increase or decrease of inelastic transmitted energy is a result of interference between these two processes. The effect of compression of the outermost shell is best manifested during ion bombardment of single crystals, when the given shell falls into the shadow of the neighboring atom of the atom layer. This effect is greatest when the radius of the shell and that of the shadow are close. Formulae are given for calculating the kinetic electron emission from single crystals under ion bombardment along various channels; the shadowing of atoms in lower layers by atoms of upper layers is taken into consideration. Curves are shown for Si under bombardment by ions of various atomic numbers and analogous curves were also constructed for luminescence yield, which is also determined by the inelastic losses. (UK)

29992 EFFECTS OF GAMMA RADIATION ON THE CURRENT-VOLTAGE CHARACTERISTICS OF ANTHRACENE FILMS. Hwang, W.; Kao, K. C. (Univ. of Manitoba, Winnipeg). Radiat. Eff.; 12: No. 1-2, 133-5(Jan 1972).

Anthracene in crystal and film forms has a potentiality for electronic devices, and some new results are reported on the changes in electrical characteristics of films after γ irradiation. Typical current–voltage curves are shown before and after irradiation. The current for a given voltage decreased with increasing radiation dose, approaching a saturation value when the integrated dose reached 5.58×10^7 R. At a fixed temperature, the higher the trap concentration created by radiation the greater the removal of traps per unit time, and saturation is reached when the rates of trap removal and introduction are in dynamic equilibrium. A theoretical treatment of the phenomenon is presented. (UK)

29993 COMPARISON OF PROTON CHANNELING IN THE (111) DIRECTION FOR BaF_2 AND CaF_2. Edge, R. D. (Univ. of South Carolina, Columbia); Hedrick, W. R.; Dixon, R. L.; Lamb, W. H. Radiat. Eff.; 12: No. 1-2, 97-103(Jan 1972).

Protons in the region of 400 keV were used to study the channeling process in BaF_2 and CaF_2. The rate of loss of protons from the ⟨111⟩ linear channel, stopping power, and critical angle for the channel were found. Two techniques were employed, namely observation of elastic scattering by the lattice ions, and alpha particles produced by the reaction $^{19}F(p,\alpha\gamma)^{16}O$, from the sharp resonance at 340 keV. The two techniques gave results in good agreement. The channel parameters were much closer together for the two crystals than anticipated on the basis of the large difference in charge between Ba and Ca. (auth)

29994 DIRECTIONAL EFFECTS IN ION SCATTERING BY SEMICONDUCTOR CRYSTALS. Molchanov, V. A.; Snisar, V. A. (Moscow State Univ.). Radiat. Eff.; 12: No. 1-2, 105-9(Jan 1972).

The spatial distributions of fast particles ejected from silicon and germanium targets bombarded with 10- to 30-keV noble gas ions were experimentally studied. All the experiments were performed for both crystalline and amorphized target surfaces. The obtained distributions were found strongly influenced by the crystal structure of the target. (auth)

29995 THEORY OF VOID FORMATION DURING IRRADIATION. Wiedersich, H. (North American Rockwell Science Center, Thousand Oaks, Calif.). Radiat. Eff.; 12: No. 1-2, 111-25(Jan 1972).

A simple theory of the swelling of materials subjected to high-energy particle irradiation is developed. Chemical reaction rate equations are used as a basis. Point defects (interstitials and vacancies) are assumed to be produced randomly throughout the solid, and move by random walk through the material until they cease to exist either by recombination with the opposite type of defect or by incorporation into the crystal at sinks such as dislocations, grain boundaries and voids. The rate equations for interstitials and for vacancies, which are coupled via the recombination term, are solved for steady-state conditions under irradiation. Defect concentrations, supersaturations, recombination and total sink annihilation rates are obtained in terms of the production rate, sink annihilation probabilities, jump frequencies, and thermal equilibrium concentrations of defects. The swelling rate is derived using sink annihilation probabilities at three principally different types of sinks, i.e., voids, sinks which have a bias with regard to the annihilation of interstitials and vacancies (such as dislocations), and sinks with no bias. The defect annihilation probabilities at void, precipitate, dislocation and grain-boundary sinks are estimated by using a cellular model and solving the diffusion equation for geometries approximating that of the cells, e.g. a concentric sphere around a void. The relative effects of different types of sinks, i.e., the microstructure, on the swelling rate are discussed. The swelling rate is integrated to give swelling-time or swelling-dose relations, making some simplifying assumptions about the changes in the sink structure as the irradiation proceeds. It is shown that the relation obtained is rather sensitive to the type of assumptions made. (auth)

29996 REVERSE BIAS CAPACITY EFFECTS AND DEFECT ENERGY LEVELS IN ELECTRON IRRADIATED GaAs p^+–n JUNCTIONS. Grimshaw, J. A. (Royal Military Coll. of Science, Shrivenham, Eng.). Radiat. Eff.; 12: No. 1-2, 87-95(Jan 1972).

Results are presented of studies of capacity as a function of reverse bias for GaAs p^+n solar cells before and after irradiation by fast electrons. The effect on capacity measurements of the presence of additional donor or acceptor defects on the n-type side is discussed theoretically. It is shown that a variety of characteristic effects can occur depending on the position of the defect energy level in the band gap and the associated time constant for electron emission and capture. It is deduced that the defects introduced by irradiation having a predominant influence on the results were a uniform concentration of deep acceptors with levels in the upper half of the gap. Other defects with deep levels in the top half of the gap were present before irradiation. The time constants were greater than 3×10^{-3} sec. It is inferred that the levels of other acceptors known to be introduced by electron irradiation are shallow and in the top half of the gap, and those of donors in the lower half. More tentatively it is concluded that few, if any, donor defects were introduced by irradiation with levels in the top half of the gap, or acceptor defects with levels in the lower half. The pre-irradiation impurity and defect concentration was essentially both uniform and unaffected by the irradiation. It is also deduced that the formation of an abrupt p^+–i–n structure does not appear to be a mechanism affecting the results. After irradiation, some recovery in the capacity values occurred after a long period at room temperature. (auth)

29997 COMPUTER SIMULATION OF THE PENETRATION AND BACKSCATTERING OF LOW ENERGY KRYPTON IONS INTO SINGLE CRYSTAL TUNGSTEN. Smith, A. G. (Univ. of Manchester, Eng.); Carter, G. Radiat. Eff.; 12: No. 1-2, 63-71(Jan 1972).

The trajectories of Kr ions in the energy range 50 eV to 5 keV incident on the (100) and (110) surfaces of W were followed, using digital computational techniques in which the interaction was

treated as a multiparticle process rather than a sequence of binary collisions. At the higher energies (>2 keV), the latter process was found to be a good description also of the multiparticle event, but at lower energies, many atoms were involved simultaneously in the ion scattering process. Probabilities of ion penetration into the surfaces were derived and compared with experimental data of Kornelsen and Sinha (J. Appl. Phys., 40: 2888(1969)) and penetration probability-energy functions shown to be similar. For the (100) surface, penetration was prohibited below an ion energy of ~400 eV and angular and energy distributions of backscattered particles in this energy range were determined. Angular analysis showed a pattern illustrative of surface atomic symmetry, but the energy distribution showed a sharply defined probability of backscattering in a narrow energy range which lies between the maximum recoil energy in a binary collision and recoil from an infinitely hard surface. This indicates that, as energy decreases, the multiple collision process can be approximately characterized as a "soft" surface of effective mass greater than the target atom mass. Because of the sharply defined energy of recoil and a quite well-defined narrow cone of backscattering, these results suggest a method of producing quite mono-energetic neutral atomic beams by recoil of ions from surfaces, since neutralization is usually highly efficient at low ion energies. The energy of ions recoiling in a collision on an axis of symmetry between surface atoms is compared with the theoretical nonbinary scattering model of Andersen and Sigmund. (auth)

29998 CRYSTAL STRUCTURE STUDIES BY MEANS OF BLOCKING AXIAL ANGULAR WIDTHS. Gverdtsiteli, I. G.; Guldamashvili, A. I.; Diasamidze, E. M.; Kalinin, A. N.; Martynenko, Yu. V. (Physical-Technical Inst., Sukhumi, USSR). Radiat. Eff.; 12: No. 1-2, 73-6(Jan 1972).

The angular width of blocking was studied for 120-keV protons backscattered from Si single crystal in various crystallographic directions. It was shown that for the ⟨111⟩ string, an effective interatomic distance which determines the critical angle of channeling is larger than the mean interatomic distance. The blocking half-width dependence on the implantation dose with 40-keV boron ions and on the following annealing temperature was obtained. The results obtained are in qualitative agreement with the theoretical ideas developed. It is demonstrated that the angular half-width studies can serve as a method of crystal structure and damage investigation. (auth)

29999 STUDY OF THE PRODUCTION AND REMOVAL OF RADIATION DEFECTS IN Ge USING SECONDARY ELECTRON EMISSION. Holmen, G.; Hoegberg, P. (Chalmers Univ. of Tech., Goteborg). Radiat. Eff.; 12: No. 1-2, 77-85(Jan 1972).

The production and removal of radiation defects in Ge(110) single crystals were studied by measuring the variation in the kinetic secondary electron emission yield during bombardment by 40-keV Ge ions. A strong dose rate effect was found in the temperature dependence of the defect production. An activation energy of 1.44 eV was calculated for the defect, which plays an important role in the removal of damage in Ge. (auth)

30000 CRITICAL ANGLES FOR AXIAL CHANNELING. Andersen, J. U.; Laegsgard, E. (Univ. of Aarhus, Denmark). Radiat. Eff.; 12: No. 1-2, 3-6(Jan 1972).

The critical angle for axial proton channeling was measured as a function of temperature for a number of different crystals. The results are consistently below the values predicted from simple analytical estimates. The magnitude of this discrepancy does not seem to depend on the specific lattice structure. All the results are consistent with a relationship $\psi_{\frac{1}{2}} = \alpha(\rho/a)\cdot\psi_1$, where ψ_1 is Lindhard's characteristic angle, and $\alpha(\rho/a)$ is a function of the thermal vibrational amplitude ρ, measured in units of the Thomas–Fermi screening distance a. A formula for $\alpha(\rho/a)$, derived by Barrett from computer simulations, on the average predicts the magnitude of α quite well, but the observed functional dependence on ρ/a is considerably stronger than predicted. (auth)

30001 $Pb_{1-x}Sn_xTe$ PHOTOVOLTAIC DIODES AND DIODE LASERS PRODUCED BY PROTON BOMBARDMENT. Donnelly, J. P.; Calawa, A. R.; Harman, T. C.; Foyt, A. G.; Lindley, W. T. (Massachusetts Inst. of Tech., Lexington). Solid-State Electron.; 15: No. 4, 403-7(Apr 1972).

N–p junction photovoltaic detectors in $Pb_{0.88}Sn_{0.12}Te$ and laser diodes in both PbTe and $Pb_{0.88}Sn_{0.12}Te$ fabricated using proton bombardment to create the n-type layer are reported. Zero-bias resistance area products as high as 1.4 Ω-cm² at 77°K and 966 Ω-cm² at 15°K were observed for 15-mil-square $Pb_{0.88}Sn_{0.12}Te$ photodiodes. At 77°K, peak detectivities at 7.5 μm as high as 2.5×10^{10} cm $Hz^{\frac{1}{2}}/W$ were measured. At 15°K, the peak detectivity occurred at 10.2 μm and in reduced background was greater than 10^{12} cm$Hz^{\frac{1}{2}}/W$. Both PbTe and $Pb_{0.88}Sn_{0.12}Te$ laser diodes operated C-W at 4.2°K. The PbTe diodes exhibited single-mode C-W laser operation up to at least 50°K and pulsed operation up to at least 80°K. (auth)

30002 MEASUREMENTS OF THE CRITICAL ANGLE FOR CHANNELING OF HEAVY IONS IN COPPER USING CHARACTERISTIC X-RAY GENERATION. Cairns, J. A.; Marwick, A. D.; Nelson, R. S.; Briggs, J. S. (Atomic Energy Research Establishment, Harwell, Eng.). Radiat. Eff.; 12: No. 1-2, 7-11(Jan 1972).

Measurements are presented of $\psi_{\frac{1}{2}}$, the width of the dip in the yield of CuL x rays when Ne^+, Ar^+, Kr^+, and Xe^+ of 150 to 350 keV are channeled in the ⟨110⟩ axis of copper. Absorption of the x rays and the slowing down of the beam are shown to limit the depth from which the detected x rays can come. The magnitude of the effect of multiple scattering on the measured values of $\psi_{\frac{1}{2}}$ is shown to be small for all the projectiles except neon. The data had a dependence on (Z_1/E) which is intermediate between that of the critical angles ψ_1 and ψ_2. A numerical calculation of critical angle gave good agreement with the data. At low energy the calculation uses a potential which is a sum of screened Coulomb and Born–Mayer terms; at higher energy, screened Coulomb alone is adequate. A simple analytical expression for the critical angle, based on a $1/r^2$ atomic potential, may be used as an approximation to the results. (auth)

30003 APPLICATION OF HIGH ENERGY-RESOLUTION SCATTERING MEASUREMENTS IN CHANNELING STUDIES. Boegh, E. (Univ. of Aarhus, Denmark). Radiat. Eff.; 12: No. 1-2, 13-19(Jan 1972).

One of the major advantages of using wide-angle scattering-yield measurements to study channeling is the possibility for confining the observed yield to a thin zone at a chosen, variable depth beneath the target surface. The thickness of this thin zone is, at least at a not too large depth, proportional to the energy resolution of the experimental apparatus used, i.e., it is usually proportional to the energy resolution of the applied particle detector. The application of a magnetic particle spectrometer which, in a random substance, yields a depth resolution of ~15 to 30 Å is described. Although this depth resolution loses some of its relevance when channeling occurs, it is possible to study details of channeling that are inaccessible in measurements where a solid-state detector is used. An example of this is demonstrated in an investigation of one single collision between particles and atomic strings and planes. (auth)

30004 AXIAL AND PLANAR CHANNELING PHENOMENA IN QUARTZ. Abel, F.; Amsel, G.; Bruneaux, M.; Cohen, C. (Ecole Normale Superieure, Paris). Radiat. Eff.; 12: No. 1-2, 35-46(Jan 1972).

Axial channeling along the [00.1] c-axis and the $[2\bar{1}.0]$ A_2-axis of α-quartz as well as planar channeling along planes containing one of these two axes were studied. The effects of silicon and oxygen sublattices were separated by using backscattering for the silicon sublattice and the nuclear reaction $^{16}O(d,p)^{17*}O$ for the oxygen sublattice. Experiments were carried out with H^+, D^+, and He^+ in the 0.5 to 2 MeV range. Results represented using well-chosen reduced coordinates follow single laws satisfactorily. For axial channeling, the full width at half minimum $1_{\frac{1}{2}}$ of the surface extinction curves depends on $\sqrt{Z_1Z_2/Ed}$. For the channeled fraction, the reduced depth is $x\rho^2dZ_1/E$, ρ^2 corresponding, even for the silicon sublattice, to the thermal vibrations of the oxygen atoms. The results obtained for the minimum yields are in good agreement with those calculated. The depth dependence of $1_{\frac{1}{2}}$ is shown. A rather weak effect is observed for silicon planes (not larger than 50 percent). For the oxygen planes, the effects are very small. Detailed calculations were carried out along the $(0\bar{1}.1)$ plane for the silicon sublattice. An angle $1_{\frac{1}{2}}$ of 18′ was measured at the surface for 0.9-MeV deuterons. A diffusion model taking into account the multiple scattering by the oxygen atoms, considered as randomly distributed scattering centers, compares favorably with the experiments. (auth)

30005 CHANNELING OF LIGHT IONS IN THE CUBIC AND TETRAGONAL (FERROELECTRICALLY POLARIZED) PHASES OF $BaTiO_3$. Gemmell, D. S.; Mikkelson, R. C. (Argonne National Lab., Ill.). Radiat. Eff.; 12: No. 1-2, 21-33(Jan 1972).

The channeling properties of thin $BaTiO_3$ crystals at temperatures both above and below the ferroelectric Curie point ($T_c \approx$ 120°C) were measured with 3.8-MeV protons. In the cubic phase ($T > T_c$), values for critical angles and minimum yields were measured for the major crystal axes and planes by detecting backscattered and transmitted protons, and characteristic x rays. These values are compared with those predicted by current theories of ion channeling. In the tetragonal phase ($T < T_c$), measurements were made with single ferroelectric domains. The channeling characteristics of the (100) planes in $BaTiO_3$ were found to be strongly dependent on the relative orientations of the electric polarization vector P, the (100) planes, and the beam direction. For

example, when P lies in the channeling plane, strong channeling occurs; but when P is normal to the plane, the incident beam is rapidly dechanneled. These effects are attributed to the relatively large ionic displacements, and the strong internal electric fields in the ferroelectrically polarized state. (auth)

30006 CHANNELING OF POSITRONS. Pedersen, M. J.; Andersen, J. U.; Augustyniak, W. M. (Bell Telephone Labs., Murray Hill, N. J.). Radiat. Eff.; 12: No. 1-2, 47-52(Jan 1972).

A beam of 1.2-MeV positrons was obtained by accelerating in a 1-MeV Van de Graaff positrons emitted by ^{58}Co. Channeling in thin silicon crystals was studied by measuring as a function of incidence angle the yield of positrons scattered through a few degrees into an annular detector. The measured axial and planar dips are compared partly to channeling dips in scattering yield for protons of corresponding energy, and partly to classical calculations as well as to calculations based on the dynamical theory of electron diffraction. In general, the results support the conclusion of a previous study of positron channeling in gold, that channeling of positrons may essentially be described by classical mechanics. In the present measurements, however, fine structure due to interference is clearly resolved. Also, for very weak planes, a complete departure from classical estimates was observed. The dechanneling rate was also studied for axial channeling by measuring the dip in crystals of different thicknesses. It was found to be very close to the dechanneling rate for protons of similar energy, in contrast to the anomalously slow rate indicated by the work of Behnisch, et.al., (Phys. Stat. Sol. 33: 375(1969)). (auth)

30007 ROSETTE MOTION AND STRING SCATTERING OF 20 MeV ELECTRONS IN MgO SINGLE CRYSTALS. Kumm, H. (Univ., Munich); Bell, F.; Sizmann, R.; Kreiner, H. J.; Harder, D. Radiat. Eff.; 12: No. 1-2, 53-61(Jan 1972).

Analytical estimates and computer simulations were undertaken to analyze the motion of negative particles through a lattice structure, the interaction being classical binary scattering. Three distinct modes of particle motion along atomic strings were found, depending on the magnitude of the transverse energy and the angular momentum L of the particle with regard to the string axis. At small and large L, increased scattering on the strings as compared with random penetration dominates. At medium L and negative transverse energy (bound state particles in the attractive potential), a rosette motion along the string occurs. In this case, small impact parameters to the string atoms are avoided and thus an increased penetrability of the negative particles results. The influence of thermal lattice vibrations on these motions was studied. Experimentally, the negative particle motion modes manifested themselves in the penetration profiles of 20-MeV electrons through an 8-μm MgO single crystal. (auth)

30008 ELECTRON MICROSCOPY OF ELECTRON IRRADIATION DAMAGES IN FOILS OF POTASSIUM CHLORIDE SINGLE CRYSTALS AT ROOM AND LOW TEMPERATURES. Kawamata, Yasuhiro (Tohoku Univ., Sendai). Tohoku Daigaku Kagaku Keisoku Kenkyusho Hokoku; 19: No. 2-3, 209-22(1970). (In Japanese).

Dislocation loops are produced in a foil of potassium chloride single crystal irradiated by a low-intensity electron beam at −110°C and room temperature. Their Burgers vectors are of the type (a/2)[011]. Moreover, irradiation at room temperature produces dislocation loops which have the Burgers vectors of the type a [001] perpendicular to the foil. After heavy irradiation, the (a′/2)[011] loops glide and vanish at the surfaces, but the loops that have the Burgers vectors parallel to the foil stay in the foil. The a [001] loops also vanish into voids by heavy irradiation. All the dislocation loops are an aggregate of molecular vacancies. (auth) (Japan)

30009 DEISTVIE RADIOAKTIVNYKH IZLUCHENII NA VESHCHESTVA. (Effects of Radioactive Radiation on Matter). Begzhanov, R. B. (ed.). Tashkent; Izdatel'stvo FAN Uzbekskoi SSR (1970). 203p.

A collection of 28 papers by various authors is presented. The effects of gamma radiation, cold neutrons, elastic scattering of electrons, and argon ion bombardment on various kinds of materials are treated. Other topics of importance include a 1,000 keV accelerator, bombardment of Si with positive Li ions, radiation-modified polyethylene, a low-voltage coaxial neutron generator, and special ionization chambers. The results of radiation change in microhardness, thermal conductivity, electric conductivity, and polymorphic conversions are discussed also. (K.S.W.)

30010 STRUCTURAL SENSITIVITY OF THE FERROELECTRIC PHASE TRANSITION AND DIELECTRIC PROPERTIES OF POTASSIUM DIHYDROGEN PHOSPHATE CRYSTALS IRRADIATED WITH FAST NEUTRONS. Peshikov, E. V. (Inst. of Nuclear Physics, Tashkent). Sov. Phys.-Cryst. (Engl. Transl.); 16: No. 5, 820-3(Mar-Apr 1972).

Translated from Kristallografiya; 16: No. 5, 947-51(Sep-Oct 1971).

Lowering of the Curie point and diminution of spontaneous polarization were observed in potassium dihydrogen phosphate crystals irradiated in a reactor. There was a sharp change in the form of the dielectric characteristics $\epsilon(T)$ and $\tan\delta(T)$ in the ferroelectric temperature range; the coercive field increased. The observed effects were due to radiation damage to the crystal structure and to interaction of defects with the domain walls. (auth)

30011 INVESTIGATION OF THE SUBSTRUCTURE OF ALUMINUM SINGLE CRYSTALS GROWN UNDER γ IRRADIATION. Konozenko, I. D.; Krulikovskaya, M. P.; Danil'chenko, B. A. (Inst. of Nuclear Research, Kiev. Inst. of Physics, Kiev). Sov. Phys.-Cryst. (Engl. Transl.); 16: No. 5, 837-41(Mar-Apr 1972).

Translated from Kristallografiya; 16: No. 5, 966-70(Sep-Oct 1971).

Aluminum single crystals were grown by a modified Bridgman method under γ radiation from ^{60}Co with an intensity of 1200 R/sec and also under the same thermal conditions but without irradiation. The substructure of the single crystals was investigated metallographically and by x-ray topography, using a white divergent beam. It was found that aluminum single crystals grown under γ radiation have a more perfect substructure than those that were not irradiated. Quantitative estimates of the parameters of the substructure are given, and a hypothesis is advanced to explain the facts described. (auth)

30012 EFFECT OF ELECTRON BOMBARDMENT ON THE ADSORPTION PROPERTIES OF CARBON DIOXIDE CONDENSED AT 20°K. Yuferov, V. B.; Sorokovoi, L. G. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 10, 1738-41(Apr 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 10, 2191-5(Oct 1971).

Layers of solid CO_2 10^{-3} cm thick have been studied. The layers are stable against low-energy electrons (up to 100 eV). Prolonged bombardment by electrons of higher energies leads to structural changes and impairment of the adsorption characteristics. Chemical bonding of adsorbed hydrogen is observed. Some data for effects of electron bombardment on the speed of a pump employing a CO_2 layer in a vacuum system are included. (auth)

30013 LOCALIZED VIBRATIONAL MODE ABSORPTION OF ION-IMPLANTED SILICON IN GaAs. Skolnik, L. H. (Univ. of Southern California, Los Angeles); Spitzer, W. G.; Kahan, A.; Euler, F.; Hunsperger, R. G. J. Appl. Phys.; 43: No. 5, 2146-50(May 1972).

Infrared absorption bands of localized vibrational modes for ion-implanted Si in GaAs are observed. Room-temperature implants were at energies of 1.0 and 1.5 MeV and fluences $\sim 10^{17}$ ions cm^{-2}. The bands previously attributed to Si_{Ga} and Si_{As} defects were observed and the dependence of the absorption at liquid-nitrogen temperature was studied for samples isochronally annealed from 200 to 900°C. The strongest band due to (Si_{Ga}–Si_{As}) pairs was observed after 400°C annealing. For most of the temperature range the different defect concentrations were found to either grow or show little change during the annealing cycle. However, between ~500 and 650°C substantial reverse annealing was observed for both Si_{Ga} and S_{As}. This effect cannot be explained by direct pair formation, and other possible explanations are suggested. For these high-fluence, high-energy implants the electrical data obtained during the anneal cycle show no apparent correlation with the Si defect concentrations as deduced from optical data. The conductivity is probably controlled by residual damage left in the implant layer. (auth)

30014 FORMATION OF MACROPORES IN LiF CRYSTALS AFTER REACTOR IRRADIATION. Feldmane, E. E. (Daugavpils Pedagogical Inst., Latvia, USSR). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 6, 44-6(1971). (In Russian).

A microscopic investigation of macropores formed in LiF crystals after reactor irradiation and high-temperature annealing was carried out. The linear dimensions of the macropores and their volumetric distribution are found to depend on the radiation dose. The dislocation density influence on the formation of the macropores is also studied. (auth)

30015 ION IMPLANTATION IN SEMICONDUCTORS. Proceedings of the II. International Conference on Ion Implantation in Semiconductors, Physics and Technology, Fundamental and Applied Aspects, Garmisch-Partenkirchen, Germany, May 24–28, 1971. Ruge, Ingolf; Graul, Juergen (eds.). New York; Springer-Verlag New York, Inc. (1971). 516p. $37.40. (CONF-710541).

Sixty-five papers and abstracts of three other papers presented at the conference are included. A separate abstract was prepared for each of the complete papers. (A.G.W.)

For abstracts of individual papers see: 28150, 28151, and 30016–30078.

30016 LOCALIZED MODE OF SUBSTITUTIONAL CARBON IN ION-IMPLANTED SILICON. Stein, H. J. (Sandia Labs., Albuquerque, N. Mex.). pp 2-6 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Substitutional carbon, C_s, incorporated into silicon by C-ion implantation was investigated using the localized vibrational mode for C_s as a monitor. A C_s/C fraction of 0.2 was observed for a uniform dopant profile obtained by a multiple-energy implant at room temperature (4.7, 7.7, and 10×10^{14} C^+/cm^2 at 60, 140, and 260 keV, respectively). C_s/C increased to ~0.75 upon annealing to 500°C. Absence of an observable C_s after 7×10^{15} 200-keV C^+/cm^2 at room temperature is ascribed to the high degree of disorder in the implanted layer. C_s was observed in this high-fluence-implanted sample after annealing to 500°C. An additional low-fluence implantation of an annealed C-implanted layer decreased C_s, consistent with a Si replacement mechanism. (auth)

30017 STRUCTURAL DIFFERENCES IN LIGHT AND HEAVY ION DISORDER IN Si STUDIED BY SINGLE AND DOUBLE ALIGNMENT CHANNELING TECHNIQUES. Hirvonen, J. K. (Rutgers–The State Univ., New Brunswick, N. J.); Brown, W. L.; Glotin, P. M. pp 8-16 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Backscattering studies of disorder in silicon due to implantation of light and heavy ions reveal differences that can be associated with the difference in defect density created along the tracks of individual ions. Comparisons of disorder measured by single and double alignment point to the importance of local strain in assessing the actual displaced-atom density. Annealing effects due to the probing beam are observed for light-ion, low-dose cases. (auth)

30018 INVESTIGATION OF ION IMPLANTATION DAMAGE WITH STRESS MEASUREMENTS. EerNisse, E. P. (Sandia Labs., Albuquerque, N. Mex.). pp 17-22 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

The stress set up lateral to the implanted surface by ion-implantation lattice damage is measured for 220-keV ^4He, ^{12}C, ^{16}O, ^{20}Ne, ^{27}Al, ^{40}Ar, ^{84}Kr, and Xe room temperature implants into Si. It is found that the ions with atomic number greater than Si produce more damage per given energy density deposited into atomic processes, 5, than the lighter ions and produce damage almost linearly with E up to a distinct maximum in the stress. The measurements from ^4He, ^{12}C, ^{16}O, ^{20}Ne, and ^{27}Al implants are indistinguishable from one another at low E values where the damage depends linearly upon E. These lighter ions introduce damage sublinearly with E at medium E values. The maximum in all the stress-versus-E results is taken as evidence for an elastic–plastic transition in the implanted layer. This elastic–plastic transition is correlated with what others have called the crystalline-to-amorphous transition. (auth)

30019 ENERGY LEVELS OF DEFECTS IN ION IMPLANTED SILICON. Davies, D. Eirug; Roosild, S. (Air Force Cambridge Research Labs., Bedford, Mass.). pp 23-32 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Thermally stimulated currents and the temperature dependence of dark leakage currents in ion-irradiated diffused junctions were used to establish defect energy levels in low-dose ion-implanted silicon. Such implants lead to the creation of at least seven different levels whose depths range from 0.25 eV to close to midgap. Defect annealing occurs in several different stages, and some of the defects initially exhibit a pronounced increase in concentration on heat treatment above room temperature. (auth)

30020 PHOTOCONDUCTIVITY OF BORON IMPLANTED SILICON. Netange, B.; Cherki, M.; Baruch, P. (Univ., Paris). pp 33-8 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Photoconductivity methods were used to investigate silicon implanted with doses of 10^{13}, 10^{14} B/cm^2 at 100 keV. Beside the photoconductivity band associated with the divacancy a photoconductivity level at ~0.4 eV is detected in the spectrum. This level has been associated with boron interstitial atoms in sites of trigonal symmetry in boron-doped silicon irradiated with electrons. Annealing experiments are performed up to 330°C. Results are complicated by the poor electrical isolation between the implanted layer and the substrate; therefore the substrate gives a certain contribution to the photoconductivity. (auth)

30021 ELECTRON PARAMAGNETIC RESONANCE ON DIVACANCIES IN PHOSPHORUS-IMPLANTED SILICON. de Wit, J. G.; Ammerlaan, C. A. J. (Univ., Amsterdam). pp 39-46 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Electron paramagnetic resonance was used to study radiation damage after implantation of 50-keV phosphorus ions into high-resistivity p-type silicon. Doses of 2×10^{14} to 10^{16} P/cm^2 are found to produce small numbers (~10^{13}/cm^2) of the S1-G7 spectrum, which arises from the single negative charge state of the divacancy. The observed introduction rate is an order of magnitude lower than the production as observed by infrared absorption. This indicates that nearly all of the divacancies are in the neutral charge state. Consequently the Fermi level must be positioned near the middle of the energy gap. Annealing studies show annihilation of divacancies around 200°C. From this result a trap concentration of 9×10^{20}/cm^3 is calculated. Details in the resonance spectra, such as linewidth and relaxation time, point in the direction of a high concentration of defects or distortions of the crystal lattice. (auth)

30022 DISTRIBUTION OF BORON IMPLANTED SILICON. Seidel, T. E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 47-57 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Random and channeled distributions of ^{11}B ions implanted into silicon were obtained for ion doses near 10^{12}/cm^2. The random projected ranges and standard deviations (30 to 300 keV) are in good agreement with calculated values when a value of electronic stopping 1.58 greater than that given by standard Lindhard–Scharff–Schiott theory is used, as was independently measured by Eisen. The channeled ⟨111⟩ distributions show maxima 1.9 to 1.5 times deeper than the random ranges for the 80- to 300-keV range. Distributions at various angles away from the ⟨111⟩ or ⟨100⟩ channels are presented, and comparisons are made between distributions implanted with [1$\bar{1}$0] planar channeling and those that have no major index planar channeling. A discussion of these results and related annealing behavior for boron-implanted silicon is given. (auth)

30023 PHOSPHORUS CHANNELED IN SILICON: PROFILES AND ELECTRICAL ACTIVITY. Moline, R. A.; Reutlinger, G. W. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 58-69 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

A nearly flat donor profile is obtained between depths of 0.4 and 1.2 microns by channeling 300-keV phosphorus ions along the ⟨111⟩ axis of silicon. The correlations among the influence of misorientation of the crystal, scattering in a thin oxide layer on the surface of the crystal, and scattering from the implantation damage on the channeled profile were studied and compared to calculations based on scattering from noncrystalline atoms. The profiles are very reproducible. They are, however, very sensitive to surface effects such as a thin layer of SiO_2 on the surface. If the aligned beam passes through 40 Å of SiO_2 before entering the crystal, the donor density is reduced by 25% at 1.1 micron. Concentrations approaching 10^{18} cm^{-3} can be obtained before the profile is substantially altered by the damage buildup. Multiple scattering effects are proportional to E^{-1}, and thus for lower energies they will become even more important. The energy effect is demonstrated with 100-keV profiles. The temperature dependence of the annealing of the sheet resistance of the channeled im-

plantations is essentially identical to that of random implantations. The effective mobility obtained from the sheet conductivity after full anneal agrees well with published values. (auth)

30024 ENHANCED ANNEALING EFFECTS OF BORON IMPLANTED LAYERS IN SILICON BY POST-IMPLANTATION OF SILICON IONS. Bauer, L.-O. (Hughes Aircraft Co., Newport Beach, Calif.). pp 70-8 of Ion Implantation in Semiconductors. Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Various effects of post-implantation of silicon ions on boron-implanted layers are reported. The amount of enhanced annealing depends critically on the target temperature during implantation and the dose of silicon used. At 100 keV, a Si dose of $5 \times 10^{15}/cm^2$ is necessary to obtain an amorphous layer extending up to the surface. The boron in this amorphous layer becomes 100% active after annealing at 600°C. When the boron dose is $\geq 3 \times 10^{15}/cm^2$, shallow silicon implantations produce stronger enhanced annealing effects than predicted on the basis of the damage produced by Si ions alone. (auth)

30025 ELECTRICAL PROFILES OF ION IMPLANTED SILICON AND THEIR COMPARISON WITH DEFECT STRUCTURES. Davidson, S. M. (Oxford Univ.). pp 79-84 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Electrical profiles were measured, using ion-beam etching as a method of layer removal, in silicon irradiated with B^+ to doses between 10^{14} and 10^{16} ions/cm^2, at room temperature and 77°K, and annealed between 400° and 1000°C. The annealing behavior is correlated with the nature and distribution of the damage. (auth)

30026 NEW METHOD FOR BORON DOPING OF SILICON BY IMPLANTATION OF BF_2-MOLECULES. Mueller, H.; Ryssel, H.; Ruge, I. (Technical Univ. Munich). pp 85-95 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

The annealing behavior of variable dose implants of BF_2 molecules was studied in comparison to boron implants. In the case of a 10^{15} cm^{-2} room temperature BF_2 implantation the annealing data indicate that an amorphous layer was formed; the sheet resistivity after 650°C anneal is a factor of 10 lower than for an equivalent-energy boron implant and the samples are nearly completely annealed. For doses of $\leq 10^{14}$ cm^{-2} there is no marked difference in the annealing of BF_2 and boron implants. These results were compared to the annealing of predamaged samples and cold implants, which show lower electrical activity. Studies of range distributions and electrical profiles were performed by He backscattering and successive layer removal techniques and show close agreement with theoretical considerations. From the electrical point of view there is no evident influence of the fluorine component of the molecule. C–V measurements were taken to determine the BF_2 behavior in SiO_2. It is shown that surface states are annealed out at 400°C. (auth)

30027 CRYSTAL DEFECTS AND ELECTRICAL PROPERTIES IN ION-IMPLANTED SILICON. Tamura, M.; Ikeda, T.; Tokuyama, T. (Central Research Lab., Tokyo). pp 96-102 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1972).

From second international conference on ion implantation in semiconductors, Garmisch–Partenkirchen, Germany (24 May 1971).

Studies were made of crystal damage in silicon produced by 100- and 150-keV B^+, P^+, and Ne^+ ion implantations. Their effects on electrical properties of the implanted layers were also studied as a function of implantation and subsequent annealing conditions. (auth)

30028 AMORPHIZATION OF SILICON CRYSTALS BOMBARDED BY 30 keV PHOSPHORUS IONS AT DIFFERENT TEMPERATURES. Eklund, K. H.; Andersson, A. (Chalmers Univ. of Tech., Goteborg). pp 103-9 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Phosphorus ions (30-keV) were implanted in p-type silicon crystals at different temperatures. The difference in the annealing behavior between an amorphous and a nonamorphous implant was used for the definition of a critical dose for amorphization by studying the sheet resistivity as a function of the annealing temperature. The variation of this critical dose with the implantation temperature was studied for a constant dose rate and the results were compared with a model for the amorphization process proposed by Morehead and Crowder. The comparison showed that the temperature-dependent volume change of the amorphous zones was proportional to $\exp(-U/kT)$ and that no particular shape of the zeros was favored. (auth)

30029 ADDITIONAL ION BOMBARDMENT OF WELL ANNEALED SILICON CRYSTALS IMPLANTED WITH PHOSPHORUS AND ARSENIC. Andersson, Ake; Swenson, Goesta (Chalmers Univ. of Tech., Goteborg). pp 110-18 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Silicon crystals with implanted layers of phorphorus and arsenic were well annealed and subsequently bombarded with small additional doses of phosphorus or arsenic ions. The changes in the electrical behavior were then studied. For both types of implanted ions there was a decrease in the number of carriers as a result of the additional bombardment. This decrease was associated with an increase in the carrier mobility for those specimens originally implanted with a high dose of phosphorus ions, but with a decrease in the mobility for those implanted with arsenic ions. Some of the specimens were isochronally annealed after the additional implantation. (auth)

30030 INFLUENCE OF ION BEAM CURRENT DENSITIES ON THE ELECTRICAL PROPERTIES OF BORON IMPLANTED SILICON. Blamires, N. G. (Atomic Energy Research Establishment, Harwell, Eng.). pp 119-23 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Samples of n-type silicon were implanted at room temperature with a dose of 1.4×10^{15} 40-keV boron ions/cm^2 at beam current densities between 0.2 and 25 $\mu A/cm^2$. The acceptor concentrations produced upon annealing at temperatures from 350 to 850°C were found to be a function of the implanted dose rates. Greater acceptor concentrations were always observed for the implantations performed at the higher dose rates. After annealing at 850°C there is variation by a factor of two in the measured acceptor concentration over the range of implanted dose rates. These results are discussed in relation to the varying nature of the damage produced at different boron ion dose rates as observed by Eisen and Welch. (auth)

30031 EVALUATION OF ELECTRICALLY ACTIVE DAMAGE IN HOT, PHOSPHORUS IMPLANTATIONS IN SILICON BY MEANS OF HALL-EFFECT MEASUREMENTS. MacDonald, C.; Galster, G. (Univ. of Aarhus, Denmark). pp 124-33 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Results of Hall-effect measurements as a function of temperature on layers formed by hot phosphorus (^{31}P) implants in Si at 400-keV energy are presented; channeled implantations are considered and doses used ranged from 10^{13} cm^{-2} to 10^{15} cm^{-2}. A detailed analysis of the measured quantities $n_{s\,eff}(T)$, the effective surface density of free carriers, and $\mu_{eff}(T)$, the effective mobility, is presented. Within the framework established by the assumptions made, the analysis provides information on the amount and distribution of compensating damage produced as a result of the implantation. Results from high-dose hot channeled implants indicate a reversal of sign of the Hall coefficient ($R_{H\,eff}$) at low measuring temperatures and at relatively low annealing temperatures. (auth)

30032 BACKSCATTERING ANALYSIS AND ELECTRICAL BEHAVIOR OF SiC IMPLANTED WITH 40 keV INDIUM. Hart, R. R.; Dunlap, H. L.; Marsh, O. J. (Hughes Research Labs., Malibu, Calif.). pp 134-40 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Backscattering analysis of SiC implanted with 40-keV In^+ is used to show that an amorphous layer is formed at 23°C after a

dose of 1×10^{14} In^+/cm^2. After 1200°C anneal the amorphous layer is largely recrystallized, and ~60% of the In atoms are along the [001] atomic rows of α-SiC. Although the measured projected range of the In^+ agrees with that calculated by Johnson and Gibbons, the standard deviation in range is over three times the calculated value. Little residual disorder remains after a 450°C implant of 3×10^{14} 40-keV In^+/cm^2 into β-SiC, and ~90% of the In atoms are substitutional following at 1200°C anneal. Although the disorder profile produced by the 23°C implant is comparable to the In distribution, the disorder profile obtained after the 450°C implant indicates a small disorder peak at depths near the maximum penetration of the In^+. No p-type conduction of the layers implanted at 23°C was observed after anneals up to 1700°C. However, a sample implanted with In^+ at 350°C did show weak p-type behavior after implantation and after anneals of 1000°C or less. Following anneals of 1200°C no p-type conduction was observed, but rather i layers of thickness comparable to that of the In^+ penetration were formed in all the implanted samples. The lack of p-type conduction is attributed to donor-type defects, which persist to 1800°C. The i-layer thickness changed with anneal temperature, suggesting the presence of mobile defects that anneal at 1600°C. (auth)

30033 ANOMALOUS DIFFUSION OF DEFECTS IN ION-IMPLANTED GaAs. Vook, F. L.; Picraux, S. T. (Sandia Labs., Albuquerque, N. Mex.). pp 141-50 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch–Partenkirchen, Germany (24 May 1971).

Lattice disorder was studied in ion-implanted GaAs as a function of implant and anneal temperature by proton-channeling-effect measurements. Nonchanneled 85-keV $^{16}O^+$ implants were made near the ⟨111⟩ axis into the A(Ga) or B(As) faces. No dependence of the lattice disorder production on the implant face was observed for implant temperatures between 87 and 296°K. For implantations at 250°K the lattice disorder production is ≈50% lower than that at 87°K and agrees with the disorder remaining following anneal of an 87°K implant to 250°K. For implantations at 87 and 250°K a disorder peak is formed at a depth that corresponds to the approximate ion range; the disorder grows linearly with ion fluence without a significant change in depth of lattice disorder. However, for low-fluence implants at 275 and 296°K the disorder peak moves to depths greater than the ion range with increasing fluence and broadens until no distinct peak can be resolved by 450-keV proton channeling. The disorder production also changes drastically from the linear dependence on ion fluence observed at ≤250°K to a nearly cube root dependence at 275 and 296°K. The deep anomalous diffusion observed for implants at ≥275°K is not observed when low-temperature implants are annealed to 300°K. This indicates that the defect or mechanism responsible for the anomalous diffusion during implantation at temperatures ≥275°K is not present upon the anneal of low-temperature implants to corresponding temperatures. (auth)

30034 ENHANCED DIFFUSION IN ION-BOMBARDED GaAs. Arnold, George W. (Sandia Labs., Albuquerque, N. Mex.). pp 151-6 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Anomalously high penetrations of Zn in GaAs were obtained by room temperature and 80°K ion bombardment of the sample surfaces prior to diffusion from a surface source. Boat-grown n-type GaAs of relatively high purity was irradiated with 10^{12} 400-keV Xe ions/cm^2 either before or after evaporative deposit of a SiO_2: Zn film from a low-viscosity alcoholic solution. Photoluminescence measurements at He temperatures showed that the characteristic emission (1.490 eV) was degraded but not shifted in energy by the ion bombardment. The samples were vacuum annealed at 500°C for two hours and the luminescence was remeasured. Masked unimplanted portions of the samples luminesced at the same energy as before heat treatment, indicating negligible Zn diffusion in this region. The irradiated portions, however, luminesced at about 1.480 eV, which is typical for transitions at the Zn acceptor level for Zn substituting for Ga in the GaAs lattice. Furthermore, the half-width and the temperature dependence of this emission is the same as for Zn-melt-doped GaAs. Measurements of the Zn luminescence as material was removed by vibratory polishing revealed little change in intensity with depth for the room temperature implant but showed a well-defined peak in the intensity at about the Xe-ion projected range (~1000 Å) for the 80°K implant. In both cases, the Zn luminescence was replaced by host-lattice luminescence at a depth of 1.22 to 1.94 μ. The implied difference in defect distributions for the two implant temperatures is in agreement with the backscattering measurements of Vook and Picraux. (auth)

30035 EFFECTS OF DOSE RATE AND IMPLANTATION TEMPERATURE ON LATTICE DAMAGE AND ELECTRICAL ACTIVITY IN ION-IMPLANTED GaAs. Harris, J. S. (North American Rockwell Science Center, Thousand Oaks, Calif.). pp 157-67 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Hall effect and Rutherford backscattering measurements were used to study the electrical properties and lattice damage, respectively, of C- and Si-implanted layers in GaAs. Implantations were performed at temperatures between 77 and 300°K and at dose rates between .06 and 20 $\mu A/cm^2$. Significant dose-rate and temperature effects in the damage were observed. These are attributed to a strong annealing stage at ~300°K. The defects that form during low-temperature implantation do not anneal up through 800°C and severely degrade the electron mobility. Room temperature 10^{13} cm^{-2} Si implants resulted in ~100% electrically active donors with complete mobility recovery after an 800°C anneal. (auth)

30036 EFFECTS OF ARSENIC ION IMPLANTATION IN GaAs. Itoh, T.; Kushiro, Y. (Waseda Univ., Tokyo). pp 168-73 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

The effects of arsenic-ion implantation on electrical properties of cadmium and tellurium layers implanted at 20 keV i.e., silicon, doped n-type GaAs were investigated for doses of 10^{14} to $10^{16}/cm^2$. Measurements of the carrier concentration profile show that a very low conductivity region exists beyond the heavily doped p-type surface layer in the cadmium-implanted specimen. Experimental results indicate that the formation of a low-conductivity layer with a thickness of few microns is due to the compensation of donor impurities in the substrate by arsenic vacancies. Some arsenic vacancies associated with donor impurities, i.e., silicon, will form stable complexes. A layer of low carrier concentration is then formed over the region where a sufficiently large number of arsenic vacancies diffuse into the substrate, provided that this arsenic-vacancy–donor complex acts as an acceptor. In order to examine arsenic vacancy diffusion during the hot implantation, arsenic implantation was performed at room temperature and 500°C, after cadmium implantation at 500°C to a dose of $10^{16}/cm^2$. These specimens showed a p–i–n structure of carrier distribution. On the other hand, arsenic-ion implantation at room temperature followed by cadmium implantation at 500°C distinctly prevent the diffusion of arsenic vacancies and the formation of the i region. The pre-implantation of arsenic ions at room temperature prevents the formation of an i region in the case of tellurium implantation. However, the pre-implantation of gallium ions at room temperature seems to enhance the formation of an i region. The injection luminescent spectra of diodes fabricated using these specimens were also investigated. (auth)

30037 IMPLANTATION OF ZINC INTO GaAs AT 1 MeV. Favennec, P. N. (Centre National d'Etudes des Telecommunications, Lannion, France). pp 174-81 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Zinc-ion implantations performed at 1 MeV were followed by suitable heat treatment to make p-type buried layers in n-type GaAs. This paper describes the results obtained on the GaAs samples implanted with ^{66}Zn at liquid nitrogen temperature, 20°C, and 300°C and for several doses. Sheet resistance measurements versus anneal temperatures, electrical profiles by Hall-effect measurements and stripping techniques and I-V characteristics of implanted junctions are reported. (auth)

30038 IMPLANTATION OF Bi INTO GaP. III. HOT-IMPLANT BEHAVIOR. Merz, J. L.; Feldman, L. C.; Mingay, D. W.; Augustyniak, W. M. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 182-92 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors, Garmisch-Partenkirchen, Germany (24 May 1971).

Channeling and photoluminescence are studied in GaP implanted with Bi at an elevated temperature (450°C), and comparison is

made with samples implanted at room temperature (25°C) and subsequently annealed at 450°C. It is found that the channeling behavion is significantly improved by the hot implant, and that the Bi is ~75% substitutional. However, no photoluminescence is observable unless the samples are annealed at temperatures in excess of 600°C. After annealing at 800°C, the luminescence intensity obtained from the hot-implant samples is compared with samples implanted at room temperature, for doses of 2×10^{13} and 1.8×10^{15} Bi ions/cm^2. For the low-dose case, hot implants increase the luminescence by only ~8%, whereas the weak luminescence observed from the high-dose samples increases by ~65%. The spectral features of the luminescence provide evidence for the presence of both strain and competing damage centers. A detailed study of the channeling angular distribution indicates that the low optical efficiencies cannot be explained by assuming that a substantial fraction of the implanted Bi ions occupy substitutional Ga sites where they would be optically inactive. (auth)

30039 INFLUENCE OF VARIOUS PARAMETERS ON RADIATION DAMAGE IN GaP. Haskell, J. D.; Grant, W. A.; Stephens, G. A.; Whitton, J. L. (Univ. of Salford, Eng.). pp 193-8 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Radiation damage due to 20-keV Te-ion implantation into single-crystal GaP was investigated by the backscattering technique. The buildup of damage was found to be a nonlinear function of ion dose. The percentage of damage retained in a target was correlated with the dopant present before implantation. Sample annealing was also investigated. (auth)

30040 RETENTION OF Bi IONS IMPLANTED IN GaAs. Tinsley, A. W.; Grant, W. A.; Carter, G.; Nobes, M. J. (Univ. of Salford, Eng.). pp 199-204 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

In an investigation of the effects of sputtering on buildup of heavy ions in semiconductors, Bi ions were implanted at 20 or 60 keV into the (110) faces of GaAs crystals at doses between 10^{13} and 10^{17}/cm^2. A plot of the number of Bi atoms retained in the GaAs as a function of the number of ions striking the target shows saturation effects at doses above 10^{15}/cm^2. Sputtering coefficients were then determined by bombarding the samples to doses of 10^{16} to 10^{17}/cm^2 and measuring the depths of the depressions formed in the sample surface. Values of the sputtering coefficient were found to be 13.3 and 4.4 atoms/ion, respectively, for 20- and 60-keV Bi ions. Possible theoretical explanations of these results are discussed. (A.G.W.)

30041 ANNEALING BEHAVIOUR OF GALLIUM PHOSPHIDE IN THE REGION 110 TO 500°K AFTER 300 keV NEON IRRADIATION. Williams, T. G.; Palmer, D. W. (Univ. of Sussex, Brighton, Eng.). pp 205-11 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Thermal annealing of defects in single-crystal GaP after 300-keV Ne^+ irradiation at about 110°K to a dose of 6×10^{13} ions/cm^2 was studied at 110 to 500°K by use of 275-keV ⟨110⟩-channeled protons by measurement of backscattering and gallium and phosphorus characteristic x-ray yields. The Ne^+ dose was insufficient to produce any completely amorphous layer. Results indicate significant annealing at about 110°K, some further annealing at 200 to 350°K and rapid annealing almost to completion in an annealing stage centered at 400°K. During both the neon irradiation and annealing, identical normalized gallium and phosphorus x-ray yields were observed. It was also found that irradiation of GaP at 103°K with 275-keV protons to doses of ~10^{16} H^+/cm^2 (unchanneled) caused significant lattice disorder. (auth)

30042 COMPENSATION OF N-TYPE GaAs BY PROTON BOMBARDMENT. Pruniaux, B. R.; North, J. C.; Miller, G. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 212-21 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

It has been shown previously that proton bombardment of N- or P-type GaAs results in the creation of compensated layers of high resistivity. This effect was studied in N-type GaAs, using protons ranging in energy from 25 to 300 keV and doses from 10^{10} to 10^{15} cm^{-2}. The profile of the compensating centers was measured, and from this the rate of removal of the free carriers by the impinging protons was determined as a function of depth. The electrical characteristics of the compensated layers were studied, particularly the resistivity as a function of proton dose and annealing temperature. The optimum dose required to produce the highest resistivity was determined. Some preliminary observations are presented about the annealing behavior of the compensation. Finally, the application of this compensation effect to achieve a semi-insulated gate GaAs field-effect transistor is discussed. In conclusion, proton bombardment results in semi-insulating layers suitable for device application. The characteristics of the field-effect transistors will be improved by using optimized geometries. (auth)

30043 ION IMPLANTED p-n JUNCTIONS IN $GaAs_{0.6}P_{0.4}$. Faulkner, K. R.; Todkill, A. (General Electric Co. Ltd., Wembley, Eng.). pp 222-7 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

P–n junctions were fabricated in n-type $GaAs_{0.6}P_{0.4}$ by implanting zinc ions at room temperature. The effect of annealing schedule upon the electrical characteristics of the implanted layers was examined. When annealed below 550°C, the layer is p-type and has a high resistivity. If the layer is annealed between 550 and 650°C, the layer has very high resistivity and shows no indications of p-type conduction; this is thought to be due to compensation of the electrically active zinc atoms by damage. On annealing at 700°C and above, the layer reverts to p-type conductivity and the sheet resistance falls rapidly with increasing anneal temperature. The optimum anneal temperature is found to be 800°C, but not all the zinc atoms are electrically active. Diodes were fabricated for electron emission studies, and their properties are compared with diffused diodes. Stable electron emission currents of 10^{-7} A were obtained for forward bias currents of 20 mA. (auth)

30044 LATTICE DISORDER AND OUTDIFFUSION IN ION IMPLANTED InSb AND CdTe. Langguth, G.; Lang, E.; Meyer, O. (Kernforschungszentrum, Karlsruhe, Ger.). pp 228-34 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Backscattering and channeling techniques of ^4He ions were used to study lattice disorder behavior in InSb and CdTe produced by Bi, Hg, and Tl ions implanted at room temperature with dose rates of 0.1 to 1 μA/cm^2. Under these conditions amorphous layers were not formed on either CdTe or InSb, even up to doses of about 10^{16} ions/cm^2. At these high doses a powder-like surface layer was formed on InSb. Average annealing temperature was found to increase with increasing dose. During isochronal anneal sequences outdiffusion of Bi and Tl atoms was observed. (auth)

30045 ION IMPLANTATION OF NITROGEN INTO n-TYPE CADMIUM SULFIDE. Shiraki, Y.; Shimada, T.; Komatsubara, K. F. (Central Research Lab., Tokyo). pp 235-40 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Ion implantation of nitrogen into n-type CdS was investigated with energy up to 200 keV at dose levels around 10^{15} cm^{-2}. The measurements of current–voltage and capacitance–voltage characteristics of implanted diodes gave evidence for p-type layer formation. The photoelectric properties of the diodes provided additional support to the type conversion. EPR measurements were employed to clarify the nature of impurity and lattice defect centers produced by the ion implantation. (auth)

30046 INFRARED STUDIES OF SiC, Si_3N_4, AND SiO_2 FORMATION IN ION-IMPLANTED SILICON. Borders, J. A.; Beezhold, W. (Sandia Labs., Albuquerque, N. Mex.). pp 241-7 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Studies of the infrared transmission properties of single-crystal silicon implanted with high fluences of carbon, nitrogen, or oxygen ions and annealed to temperatures ≤1000°C indicate that SiC, Si_3N_4 or SiO_2 microregions, respectively, are formed. These compounds were identified by their characteristic phonon

absorption bands. SiC is observed to form after annealing at 850°C for 20 minutes, but the formation of Si_3N_4 and SiO_2 requires a temperature of 1000°C for about 15 hours. Immediately after implantation, and at annealing temperatures lower than that required for compound formation, broad featureless absorption bands are observed, whose positions and annealing behaviors are dependent on the implanted ions. (auth)

30047 ION IMPLANTATION AND AMORPHOUS MATERIALS. Olley, J. A.; Yoffe, A. D. (Cavendish Lab., Cambridge, Eng.). pp 248-54 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

The possibilities of using heavy-ion bombardment to produce and study amorphous films of semiconductors and to investigate the properties of single crystals as more and more disorder are discussed. Results of studies on As_2Se_3 and MoS_2 are reported. (auth)

30048 RAMAN SPECTRA OF AMORPHOUS SEMICONDUCTORS PREPARED BY ION BOMBARDMENT. Crowder, B. L.; Smith, J. E. Jr.; Brodsky, M. H.; Nathan, M. I. (IBM Watson Research Center, Yorktown Heights, N. Y.). pp 255-61 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Raman scattering was observed in amorphous C, Si, Ge, GaP, GaAs, InSb, and GaSb prepared by ion bombardment of the corresponding single-crystal phase. This technique was used to study the crystalline/amorphous transition in surface layers of ion-implanted Si and to study the influence of annealing on continuous amorphous Si surface layers. Raman scattering was employed to determine that the short-range order in the amorphous phase produced by ion bombardment of diamond is not the same as that in crystalline diamond. The amorphous phases produced in diamond and graphite are essentially identical. Ion damage produces broadening and shifts in peak location of crystalline Raman line(s), which can be attributed to ion-implantation-induced compressive stresses. (auth)

30049 EFFECTS OF IMPLANTATION ON THIN LAYERS OF ALUMINUM METALLIZATION ON SILICON. Lee, D. H.; Marsh, O. J.; Hart, R. R. (Hughes Research Labs., Malibu, Calif.). pp 262-6 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Evaporated aluminum layers 300 to 1500 Å thick on silicon were bombarded with $^{28}Si^+$, $^{31}P^+$, and $^{75}As^+$ ions at energies from 70 to 150 keV. The implantations were performed at target temperatures 23 and −196°C with subsequent isochronal anneals from 100 to 650°C. Rutherford-backscattering results suggest that diffusion and migration are occurring between the metallization and the implanted semiconductor at temperatures significantly below the Al−Si eutectic of 577°C. These enhanced effects are influenced primarily by the presence of an amorphous layer at the interface; the dopant characteristics of the ion and the electrical properties of the semiconductor play a minor role. Furthermore, the data indicate a recrystallization of the amorphous region at temperatures as low as 350°C. Implanted planar devices also show similar results; however, ion penetration of aluminum metallization residing on silicon-dioxide interfaces does not exhibit the above phenomena. (auth)

30050 CRYSTALLINE TO AMORPHOUS TRANSFORMATION IN ION-BOMBARDED SILICON. Beezhold, Wendland (Sandia Labs., Albuquerque, N. Mex.). pp 267-73 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Lattice expansion in oxygen-bombarded Si was measured as a function of average energy into atomic processes per unit volume, $\bar{E}$, and to post-bombardment annealing temperature. Crystalline defects such as the divacancy, localized modes of implanted O^+, and changes in the band edge absorption were also measured for the same ranges of $\bar{E}$ and of post-bombardment annealing temperature. For single energy implants, two transitions were found for the lattice expansion versus $\bar{E}$. The first, $\bar{E}_1$, is the point at which saturation of the expansion first begins. Below $\bar{E}_1$, both expansion and simple defects have an annealing stage around 150°C. Above $\bar{E}_1$, the lattice expansion reaches a plateau until $\bar{E} \geq \bar{E}_2$. For $\bar{E}_1 < \bar{E} < \bar{E}_2$, annealing of the expansion does not correlate with annealing of the simple defects. The region between $\bar{E}_1$ and $\bar{E}_2$ is described by other authors as amorphous. However, crystalline defects are observed in this region. At $\bar{E}_2$, the lattice expansion sharply increases. The change at $\bar{E}_2$ is believed to result from further expansion as macroscopic disorder occurs throughout the implanted region. (auth)

30051 ANALYSIS OF CONTACT FORMATION AND SURFACE LAYERS ON SEMICONDUCTORS. Mayer, J. W.; Mitchell, I. V.; Nicolet, M.-A. (California Inst. of Tech., Pasadena). pp 274-86 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

MeV He-ion backscattering and channeling-effect measurements used to analyze surface layers on semiconductors are reviewed. Backscattering techniques provide both mass and depth resolution; channeling effects provide structural information and a determination of line shapes of analysis of amorphous layers on crystalline substrates. Examples are given for analysis of the composition of dielectric layers, diffusion through passivating layers on GaAs, low temperature migration of Si in metal films, and alloying behavior of Au on GaAs. (auth)

30052 NEW ASPECTS OF ATOM LOCATION: FLUX PEAKING. Eisen, F. H. (Univ. of Aarhus, Denmark). pp 287-96 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

The flux peaking effect is discussed qualitatively, and the effects of various factors that tend to influence flux peaking are reviewed using the recent calculations of Van Vliet. Experimental results obtained using Yb-implanted silicon, including recent unpublished data, are discussed. The need to measure the angular dependence of the reaction of channeled ions with the atoms studied in location experiments is emphasized, and some of the effects of flux peaking on the interpretation of measurements of disorder in crystals are discussed briefly. (auth)

30053 USE OF ION-INDUCED X-RAYS TO INVESTIGATE THE CONCENTRATION DISTRIBUTION AND ATOM LOCATION OF BORON-IMPLANTED SILICON. Cairns, J. A.; Nelson, R. S.; Briggs, J. S. (Atomic Energy Research Establishment, Harwell, Eng.). pp 299-306 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Use of 40-keV protons to measure the concentration profiles of boron implanted into silicon is described. The protons are used to generate boron-K x rays (~180 eV), which are shown to arise predominantly from within 350 Å below the silicon surface. In order to minimize the interfering effect of silicon L x rays (~100 eV), which are generated simultaneously, a specially developed boron filter was incorporated into the x-ray detector. The samples investigated were implanted with boron at 100, 200, and 300 keV, to a dose of 5×10^{16} boron ions/cm^2. In a preliminary investigation of the lattice location of the implanted boron, results consistent with the boron occupying sites along the ⟨110⟩ atomic rows were obtained. (auth)

30054 ELECTRICAL PROPERTIES OF ION IMPLANTED GERMANIUM. Herzer, H.; Kalbitzer, S. (Max-Planck Institut fuer Kernphysik, Heidelberg). pp 307-14 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Ions of B, Ga, P, and As were implanted into germanium at room temperature. The energies ranged between 4 and 30 keV. Doses of 10^{13}, 10^{14}, and 10^{15} ions/cm^2 were applied. After successive annealing steps at temperatures up to 600°C the layers were measured by Hall-effect and sheet-resistivity techniques. All implants, except Ge(B), show annealing thresholds between 200 and 400°C. Ge(B) is already electrically active in the as-implanted state. The maximum electrical yield is roughly proportional to the ion dose in all cases. Doping profiles of B, P, and Ga implants in ⟨111⟩ and ⟨110⟩ directions were determined by electrical and layer-removal techniques. Deep penetrating fractions due to channeling and diffusion are observed. The electrical yields amount to ~20% for Ge(B) and Ge(P) and ~80% for Ge(Ga) implants. (auth)

30055 RECENT ADVANCES IN ION IMPLANTED MOS TECHNOLOGY. Dill, H. G.; Toombs, T. N.; Bauer, L. O. (Hughes Aircraft Co., Newport Beach, Calif.). pp 315-28 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

The latest progress in ion implantation as applied to field-effect devices is discussed. After a survey of the different devices and circuit applications, problems of implanting through a passivation layer and annealing are considered. The main part describes new device and circuit applications now in production or under development. (auth)

30056 RECENT ADVANCES IN ION IMPLANTED JUNCTION-DEVICE TECHNOLOGY. Mac Rae, A. U. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 329-34 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Recent applications of ion implantation to the fabrication of silicon discrete and integrated circuits indicates that this process may be used successfully in each step involving doping of the silicon. Techniques have been developed to fabricate the diode array for Picturephone®, room-temperature double-implanted high-gain transistors, and buried layers for integrated circuits. The successful fabrication of these structures overcomes some previously considered limitations of the ion-implantation process. (auth)

30057 ENHANCED DIFFUSION OF SUBSTRATE IMPURITIES INTO EPITAXIAL LAYERS IN Si BY PROTON IRRADIATION. Ohmura, Y.; Abe, T.; Mimura, S.; (and others) (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan). pp 335-9 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Enhanced diffusion of n^+ substrate impurities Sb and P into epitaxial layers in Si by proton irradiation is observed and analyzed using a simple Gaussian impurity diffusion coefficient in terms of steady-state excess vacancy distribution. The maximum diffusion coefficients obtained when 30 $\mu A/cm^2$ proton beams at 300 to 450 kV are used at 900°C are 4000 to 7000 times as large as the thermal diffusion coefficients for Sb and P in Si. The standard deviation of 1 μm or a little smaller for the Gaussian diffusion coefficient is reasonable for 300- to 450-kV proton irradiation. The vacancy lifetime and the diffusion length are estimated to be of the order of magnitude of 10^{-5} s and 0.1 μm, respectively. Enhanced diffusion techniques are applied to the formation of pillar-like collectors for an n–p–n microwave transistor. The power gain is improved by 1 db at 4 GHz by the reduction of parasitic base-collector junction capacitance. (auth)

30058 JUNCTION FIELD EFFECT TRANSISTORS FABRICATED BY ION IMPLANTATION. Bobenrieth, A.; Tung, Pham Ngu; Arnodo, C. (THOMSON-CSF-Laboratoire Central de Recherches, Orsay, France). pp 340-4 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Ion implantation is well adapted to the realization of discrete or integrated field-effect transistors operating at high frequency ($f \geq 1$ GHz), having a small pinch-off voltage ($V_p \simeq 1$ V), and eventually capable of being operated solely by forward biasing of the gate junction ($0 \leq V_g \leq 0,5$ V). Studies of the structure and fabrication of ion-implanted field effect transistors now under way in this laboratory are described and the results obtained to date are presented. (auth)

30059 MICROWAVE TRANSISTORS FABRICATED BY ION-IMPLANTATION: SELECTION OF DOPING IMPURITIES AND PROTOTYPE REALIZATION. Morizot, M.; Dubee, A.; Cornette, A. (THOMSON-CSF-Laboratoire Central de Recherches, Orsay, France). pp 345-50 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

First attempts to realize microwave transistors by ion implantation were made on a 2N 918 structure. The selection of doping impurities was accomplished after a study of the implantation profiles obtained by a rapid process developed in this laboratory. Base-diffused emitter-implanted transistors were realized. The gain is about 50 and the f_T is similar to that of the diffused transistor. Studies are in progress on small-dimension transistors. (auth)

30060 APPLICATION OF ION IMPLANTATION TO N-P-N-TRANSISTORS. Assemat, J. L. (Lignes Telegraphiques et Telephoniques, Conflans-STE-Honorine, France). pp 351-6 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Transistors were made either entirely by ion implantation or by implantation of the base before or after emitter diffusion. A multi-implantation process through a thin layer of SiO_2 was used. Ion energies were 30, 54, and 100 keV for P and 16, 30, 55, and 100 keV for B. The doses used gave a maximum doping of 5×10^{20} atoms/cm^3 for P and 10^{19} atoms/cm^3 for B. The annealing temperatures were 650°C for P and 900°C for B. Transistors showed good hf behavior. A reduction of leakage currents and an increase of gains is noted passing from entirely implanted transistors to implanted-base and diffused-emitter transistors. (auth)

30061 NEW TECHNIQUES FOR IMPROVING HIGH VALUE ION IMPLANTED RESISTORS. Nicholas, K. H.; Ford, R. A. (Mullard Research Labs., Surrey, Eng.). pp 357-61 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

High-value resistors are often required in integrated circuits. Ion implantation, with its good control of low doses and its shallow layers, is an ideal technique for producing such resistors. The factors that limit the maximum reproducible sheet resistance to about 50 $k\Omega/cm^2$ in integrated circuits are described. They further limit the resistance to about 10 $k\Omega/cm^2$ if good linearity is required. The values can be increased by reducing the mobility. This has been achieved by implanting neon as well as boron into the resistor region. The electrical properties of the layers are satisfactory and linear high-value resistors have been made reproducible in this way. These facilitate the fabrication of faster, lower-power, and more compact circuits. (auth)

30062 PIEZORESISTIVE PROPERTIES OF ION IMPLANTED LAYERS IN SILICON. Donovan, R. P. (Research Triangle Inst., Durham, N. C.); Littlejohn, N. A.; Roosild, S. A. pp 362-72 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

The gage factor and temperature coefficient of gage factor of the following implanted layers in silicon were measured: (1) lightly and heavily doped phosphorus-implanted layers; (2) low-temperature and room-temperature boron-implanted layers; (3) impurity-compensated layers, doped with both boron and phosphorus. All these layers reflect the presence of deep damage centers in the silicon, the magnitude of the effect being related to the temperature of annealing. A minimum annealing cycle is required to achieve adequate junction isolation between the ion-implanted layer and the substrate. A significant density of damage centers remains after all annealing cycles. These centers alter the carrier concentration under various strains and temperatures. Their effect can be additive or compensating to the gage factor of the damage-free resistor. (auth)

30063 SURFACE STATES INDUCED BY ION IMPLANTATION. Fahrner, W.; Goetzberger, A. pp 373-82 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Surface states induced by N^+-, K^+-, and Si^+-ion implantation into SiO_2–Si interfaces were measured under various conditions of ion energy, fluence, oxide thickness, etc. Implantation into oxides of different thickness and annealing behavior show that the effects fall roughly into two groups: deep implantation through the interface and shallow implantation into the oxide surface only. There is a discrepancy of about a factor of 5 between ranges calculated by Lindhard–Scharff–Schiott theory and the measured range in the case of shallow implantation. This is attributed either to electromagnetic radiation arising during implantation or electron–hole pair generation. Analysis of time constant distribution

shows that an infinite trap distribution is built up in the oxide. (auth)

30064 SPEED IMPROVEMENT OF ION IMPLANTED SELF ALIGNED GATE MOS TRANSISTORS. Bernard, J. pp 383-8 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

A technological process for P-channel self-aligned-gate ion-implanted MOS transistors is presented and the performances obtained are compared to the results obtained by a conventional thermal diffusion process. In terms of static characteristics, ion implantation leads to the same results as thermal diffusion for carrier mobility in the channel and threshold voltage but gives higher punch-through voltage between drain and source because of the very shallow implanted junctions. Dynamic characteristics are presented: small-signal measurements lead to a maximum frequency of oscillation of 1.1 GHz; large-signal behavior checked by means of a ring of invertors shows that the speed is improved by a factor of 5.8 with respect to the same diffused invertor, the propagation time of the ion-implanted invertor being 5.5 ns. The behavior of self-aligned ion-implanted MOS transistors is related to the influence of gate-drain capacitance and drain-bulk capacitance showing that ion implantation allows the designing of high-speed high-complexity MOS-transistor integrated circuits. (auth)

30065 CHEMICAL AND ELECTRICAL BEHAVIOUR OF ION IMPLANTED SiO_2 FILMS. Monfret, A. (RTC-LA Radiotechnique, Caen, France); Bernard, J. pp 389-96 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

SiO_2 films are extensively used in ion-implanted semiconductor device technology. Ion-implantation effects on these films have therefore been studied in terms of electrical and chemical properties, as functions of various parameters: ion species, implanted doses, and annealing temperatures. Results dealing with chemical effects, showing the enhanced etching rate of SiO_2 layers in buffered HF as a function of the ion dose are presented. As an application of this property, a simple method for checking implantation uniformity is presented. Results dealing with electrical behavior show the bombardment effects on the oxide charge, the breakdown voltage, and the leakage current through the oxide. It is concluded that for implanted-ion concentration lower than 10^{21} ions/cm^3, no specific restriction exists in the use of SiO_2 films in ion-implantation semiconductor device processing. (auth)

30066 ION IMPLANTED THERMORESISTIVE DEVICE FOR CRYOGENIC TEMPERATURES. Bernard, J.; Guernet, G.; Montier, M.; Peccoud, L. (CNRS, Grenoble, France). pp 397-403 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

An ion-implanted silicon sensor is presented where conductivity variation of the semiconductor with temperature is monitored; the useful range of temperature measurement is determined by the dopant concentration of the implanted layer. The advantages of ion implantation technology as compared with other methods are pointed out, with respect to precision and reproducibility of the doping level. Results obtained on devices implanted with phosphorus ions show that temperatures in the range 4 to 1°K can be measured with a sensitivity of 0.65 kΩ/°K, and measurement can possibly be extended below 1°K. (auth)

30067 ION IMPLANTED LIGHT SENSING DIODES. Peterman, D. A.; Dexter, R. J.; Echols, R. W.; Morgan, I. H. (Texas Instruments Inc., Dallas). pp 404-9 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Ion implantation has been utilized as a means of producing p–n junction photodiodes by implanting boron into n-type silicon. Since the spectral photoresponse depends strongly on the dopant profile obtained, ion implantation offers a distinct advantage in terms of control and uniformity. One application of silicon photodiodes is for camera shutter control systems. In this case, the diode should be very shallow to produce maximum response in the green region of the spectrum. Light sensors were made by both ion implantation and by conventional diffusion doping processes. Spectral response measurements with and without a blue filter demonstrated ion implantation to have an advantage in responsivity and spectral matching. In addition, ion implantation gives tighter distributions and control of device parameters. (auth)

30068 APPLICATION OF ION IMPLANTATION TO AVALANCHE MULTIPLICATION DEVICES. Gibbons, P. E. (Atomic Energy Research Establishment, Harwell, Eng.). pp 410-13 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

A multiplying structure was fabricated by ion implantation. Gains of tenfold were observed with good lateral uniformity and freedom from microplasmas. (auth)

30069 NEW ION IMPLANTATION AREAS. Brown, W. L. (Bell Telephone Labs, Murray Hill, N. J.). pp 430-8 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

The potential applications of ion implantation to control of the properties of solids at and near their surfaces cover a very broad range. Two of the newer areas are discussed: index of refraction modification in fused quartz and magnetic anisotropy control in rare earth iron garnets. (auth)

30070 NON-GAUSSIAN IMPLANTATION PROFILES. Dearnaley, G.; Wilkins, M. A.; Goode, P. D. (Atomic Energy Research Establishment, Harwell, Eng.). pp 439-54 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

The distribution profile of ions implanted into single crystals frequently departs from the Gaussian form expected in amorphous solids. The reasons for this include ion channelling and various types of anomalous diffusion. The experimental evidence for such processes is reviewed, mostly for the case of silicon, and it is shown that though under some circumstances one type of mechanism may be dominant, at other times a different one is important. It is proposed that, besides the diffusion of interstitial or substitutional phosphorus after implantation into silicon, another possible transport mechanism is the migration of phosphorus-vacancy pairs through the lattice. Some implications of these ideas from the point of view of device applications are briefly discussed. (auth)

30071 ATOM LOCATION IN THE CASE OF ENHANCED DIFFUSION MEASURED BY BACKSCATTERING METHOD. Masuda, K.; Gamo, K.; Imada, A.; Namba, S. (Osaka Univ.). pp 455-8 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

The ratios of substitutional and interstitial implanted atoms to total implanted atoms were studied by the He-ion backscattering method. Depth distributions of those ratios were obtained. It is concluded that vacancy-assisted diffusion occurs in the case of Ga implantation and interstitial diffusion occurs in the case of In implantation in silicon. (auth)

30072 ENHANCED DIFFUSION AND ELECTRICAL PROPERTIES OF ION IMPLANTED SILICON. Gamo, K. (Osaka Univ.); Iwaki, M.; Masuda, K.; (and others). pp 459-65 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Indium and antimony were implanted in silicon and concentration profiles were measured by means of radioactivation analysis. The Hall effect was also measured. The difference between the concentration profiles in single-crystal silicon and amorphous silicon was investigated. It was observed that high-temperature ion-implanted indium shows no enhanced diffusion below 200°C and that it shows temperature-independent enhanced diffusion above 300°C. Indium shows no enhanced diffusion in highly damaged regions and the migration of indium seems to be terminated by trapping at defects. Enhanced diffusion of antimony seems to take place via vacancy. (auth)

30073 PRESENCE OF DEEP LEVELS IN SILICON IMPLANTED WITH CHANNELED LOW ENERGY PHOSPHORUS IONS. Urli, N. B. (Inst. Rudjer Boskovic, Zagreb). pp 466-

72 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Phosphorus ions (40-keV) were implanted in p-type boron-doped silicon in the ⟨111⟩ ± 1° direction. Low fluences of 10^{13} and 10^{14} ions/cm^2 were used in order to prevent the formation of an amorphous surface layer. The temperature dependence of the Hall coefficient and sheet resistivity measurements were made on "mesa" structure samples after annealing at higher temperatures starting from 250°C. Besides the shallow phosphorus donor level ($E_c - 0.044$ eV) found in the highly compensated samples annealed at 250°C and implanted with 10^{13} ions/cm^2, several deeper localized energy levels such as 0.14, 0.17, and 0.21 eV below the conduction band were detected after 450°C and higher temperature annealing steps. An attempt was made to correlate the energy levels with those reported for fast neutron bombardment. Changes in the effective mobilities and the increase in the capacitance of the p–n junctions during annealing processes as well as the possible influence of longer annealing times on the growth, modification, and annealing of lattice defects were also discussed. (auth)

30074 MOBILITY, RESISTIVITY, AND CARRIER CONCENTRATION MEASURED ON SILICON IMPLANTED WITH CHANNELED AND NONCHANNELED INDIUM IONS. Astrup, G.; Johansen, A.; Olsen, J. S.; Sarholt-Kristensen, L. (Univ. of Copenhagen). pp 473-84 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Hall-effect and resistivity measurements as a function of temperature, annealing temperature, and dose were carried out on silicon samples implanted with 70-keV indium ions. The implantations were performed in random as well as in channeled directions (⟨111⟩), and doses of 10^{13}, 3×10^{14}, and 10^{16} ions/cm^2 were used. All the electrical measurements were made after successive isochronal (10 min) annealing treatments (20 to 900°C). The electrical measurements were combined with anodization-peeling techniques in order to investigate the depth dependence. The impurity profile was also determined. (auth)

30075 IONIZATION ENERGY DETERMINATION IN INDIUM IMPLANTED SILICON. Pashley, R. D. (California Inst. of Tech., Pasadena). pp 485-8 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Hall effect and electric conductivity were measured as a function of temperature in conjunction with layer removal to determine the ionization energy in indium-implanted silicon. Similar measurements were performed on silicon shallow-diffused with indium to verify the analysis procedure. In both cases, an indium energy level of 160 meV was observed, which agreed with the bulk-doped value. (auth)

30076 SOME OBSERVATIONS ON HIGH ENERGY NITROGEN IMPLANTATIONS IN SILICON. Stephen, J.; Smith, B. J.; Hinder, G. W.; Marshall, D. C.; Wittam, E. M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 489-94 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Some physical and electrical measurements made on 3-MeV-nitrogen implanted layers in silicon for a range of ion doses and annealing temperatures are reported. The work concentrated on the crystal perfection and the electrical properties of the buried layer and the region above it. The crystal perfection was observed by the electron channelling patterns formed when the specimen was examined in a scanning microscope. The types and electrical activities of the layers were measured by thermal-probe, four-point-probe, and capacitance– voltage methods. I/V measurements were made on shallow diffused and implanted diodes and resistors in the region above the buried layer. Simple p–n–p structures were made by etching deep mesas through the buried implanted layer. The I/V characteristics are those of a pair of back-to-back p–n diodes confirming the presence of the n layer. The results show that the buried layer is n-type and that approximately 1% of the number of implanted ions are electrically active after a 900°C anneal. The depth of the buried layer agrees reasonably well with the Lindhard–Scharff–Schiott theory and the p layer above the buried layer is crystalline after implantation and before annealing even for the heavy ion dose (10^{16} ions/cm^2). (auth)

30077 NITROGEN IMPLANTATION OF p-SILICON AT CRYOGENIC TEMPERATURES. Pronko, P. P.; Mitchell, J. B.; Shewchun, J. (McMaster Univ., Hamiliton, Ont.). pp 495-8 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Ion implantation of nitrogen in silicon was studied at 28 and 283°K. Van der Pauw–Hall measurements and sheet resistivity were used to characterize the electrical properties of the implanted layer. Low-temperature implants produce an essentially total amorphous layer, which upon annealing shows enhanced carrier concentrations. The relative amount of amorphization is determined through backscattering measurements. (auth)

30078 CONDUCTIVE PROPERTIES OF THE ION IMPLANTED BINARY SYSTEM $Si_{1-x}Al_x$. Kraeutle, H.; Kalbitzer, S. (Max Planck Institut fuer Kernphysik, Heidelberg). pp 499-506 of Ion Implantation in Semiconductors. /Ruge, Ingolf (ed.). New York; Springer-Verlag New York, Inc. (1971).

From second international conference on ion implantation in semiconductors; Garmisch-Partenkirchen, Germany (24 May 1971).

Ion doses of up to about 5×10^{17} Al/cm^2, at 20 keV energy, were implanted into silicon at room temperature. The electrical properties of the implanted layers were measured as a function of ion dose and annealing temperature. Metallic conduction was observed at doses in the order of 10^{17} Al/cm^2. Sheet resistivities of about 10 Ω/cm^2 were obtained. After annealing above 600°C all samples were p-type semiconductors. The experimental results are discussed in terms of physical processes such as hopping, percolation, and precipitation. (auth)

30079 THERMOSTIMULATED CONDUCTIVITY AND TRAPPING CENTERS IN IRRADIATED MgO. Mallard, W. C.; Crawford, J. H. Jr. (Univ. of North Carolina, Chapel Hill). J. Appl. Phys.; 43: No. 5, 2060-6(May 1972).

Thermostimulated conductivity (TSC) measurements, reinforced on occasion by thermoelectric power measurements, were made on gamma-irradiated MgO crystals from several sources after a variety of thermal treatments. It was confirmed that the TSC peak near 90°C is associated with the escape of holes from V^- centers. In addition, a persistent electron current extending to below 200°K was observed in relatively high-purity (low-iron) crystals which appears to be associated with shallow electron traps. The free electrons responsible for it are inhibited from recombining with holes in V^- centers by Coulomb repulsion. Annealing and air cooling from 1400°C eliminates this electron current and suppresses the overall amplitude of the thermally stimulated current. The cause of this suppression and the relative insensitivity of the TSC curve to thermal treatment below this temperature are examined on the basis of a simple kinetic model. (auth)

30080 EFFECT OF ELECTRON CHANNELING ON DISCHARGE FORMATION IN CRYSTALLINE DIELECTRICS. Vershinin, Yu. N.; German, V. G. (Scientific-Research Power Inst., Novosibirsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 10, 2635-6(Apr 1972).

Translated from Fiz. Tverd. Tela; 13: No. 10, 3132-3(Oct 1971).

Possible discharge directions in halite, fluorite, calcite, quartz, and topaz with a negative point polarity are examined on the basis of the channeling effect. The experimental results are compared with data for a point with a positive polarity. If the anion chains coincide with the continuous channels of maximum cross section, the discharge directions coincide for both polarities (fluorite, calcite, and topaz). (D.L.C.)

30081 COLORATION OF LiF BY 56-MeV α PARTICLES AND 28-MeV DEUTERONS. I. OBSERVATION OF COLOUR CENTRES PRODUCED AT ROOM TEMPERATURE. Thevenard, P.; Perez, A.; Davenas, J.; Dupuy, C. H. S. (Claude Bernard Univ., Lyon). Phys. Status Solidi (a); 9: No. 2, 517-22(16 Feb 1972).

Color-centers were induced in LiF by bombardment with 56-MeV α particles and 28 MeV deuterons at room temperature. The nature and the evolution of these centers were studied by optical absorption spectra obtained at 300 and 77°K, and after thermal annealing. F-centers and F-aggregate centers were observed as well as many ionized F-aggregate centers (F_2^+, F_3^-, F_3^+, F_3^-) and some other bands near 2750, 4250, 4400, 4950, and 5300

Å at LNT. The 4250 and 4400 Å bands exhibited a weak vibrational structure. When samples were annealed at temperatures above 600°K, only the 2750 Å band and a wide flat band near 4350 Å remained; it is suggested that they are colloidal bands. (auth)

30082 ELASTORESISTIVITY: A PROPERTY ESPECIALLY SENSITIVE TO STAGE I RADIATION DEFECTS IN COPPER. von Stebut, J. (CEN, Fontenay-aux-Roses, France). Phys. Status Solidi (a); 9: No. 2, K145-8(16 Feb 1972).

Results concerning the elastoresistivity coefficient of Cu are reported. It was found that, except for the very beginning of irradiation, the coefficient was a linear function for resistivity increase and thus of defect concentration. Stage I D annealing caused the coefficient to drop to almost zero while only a 38% decrease of radioinduced bulk resistivity and a 3% depinning took place. Following a slight dip in stage II, the coefficient antirecovered in stage III. From these results it was concluded that stage I elastoresistivity is due to a dielastic relaxation, which means a deformation (polarization) of the strain field around an interstitial under external stress, which in turn affects the electron scattering potential. This interpretation implies that a strain $\epsilon = 10^{-3}$ gives rise to a 0.5% increase in the effective interstitial scattering potential. (P.C.H.)

30083 FAST-NEUTRON-IRRADIATION-INDUCED RESISTIVITY IN METALS. Horak, J. A.; Blewitt, T. H. (Argonne National Lab., Ill.). Phys. Status Solidi (a); 9: No. 2, 721-30(16 Feb 1972).

The residual resistivity increase rate as a function of induced resistivity for fast-neutron-irradiated Al, Cu, Ag, Au, Pt, Fe, Ni, Co and Mo was studied. Except for Fe, the resistivity increase rate as a function of radioinduced resistivity was nonlinear. The data is best explained with the expression of Balarin and Hauser. Saturation values of the resistivity and defect concentrations plus static and dynamic recombination volumes were calculated; they differed from those obtained by irradiation in a reactor spectrum. Recombination volumes were very small for the bcc metals Fe and Mo. (auth)

30084 MONTE CARLO CALCULATIONS OF THE BLOCKING EFFECT. Ryabov, V. A. (Inst. of Physics and Energetics, Obninsk, USSR). Phys. Status Solidi (b); 49: No. 2, 467-73(1 Feb 1972).

The angular distribution of fast charged particles originating at the lattice sites is studied by computer simulation. Multiple scattering effects were found to be necessary for agreement with the experiment in the planar case. The dependence of the intensity of multiple scattering on crystal thickness and temperature is discussed. Detailed calculations of the blocking pattern are performed for the [100] and [111] directions of a simple lattice (bcc). It is shown that the case of emitting nucleus displacement from the lattice site, the most sensitive parameter of the distortion is the value of the originating planar shoulder near a low-index direction. The distortion of the blocking pattern is calculated as a function of the compound nucleus lifetime. (auth)

30085 CONVERSION AND EQUILIBRIUM BETWEEN F AND F_2 CENTERS IN X-IRRADIATED KCl. I. SLOW WARMUP EXPERIMENTS. Seager, C. H.; Welch, D. O.; Royce, B. S. H. (Princeton Univ., N. J.). Phys. Status Solidi (b); 49: No. 2, 609-17(1 Feb 1972).

Measurements are reported in which the number of F_2 centers produced by warming crystals previously x-irradiated at liquid-nitrogen temperatures is studied as a function of temperature and crystal purity. These data are analyzed in terms of a diffusion model in which the energy of migration and the initial F^+ center distribution are adjustable parameters. It is shown that the best fit is obtained with an energy of motion of negative ion vacancies (F^+ centers) of 0.66 eV and a vacancy distribution such that the F^+ centers tend to be within five nearest neighbor distances of the F centers. (auth)

30086 ON THE EFFECT OF IRRADIATION INTENSITY ON DEFECT PRODUCTION IN PURE AND IODINE-DOPED KCl AT ROOM TEMPERATURE. Goldstein, F. T. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Status Solidi (b); 49: No. 2, 711-19(1 Feb 1972).

A study was made of the room-temperature coloration of pure and iodine-doped KCl. Various intensity-dependent effects were observed. These include the nature of the V bands as well as the shape of the F growth curve. (auth)

30087 OPTICAL BLEACHING AND F → M CONVERSION IN DOPED KCl CRYSTALS. Srinivasan, T. M.; Sastry, E. V. R. (Indian Inst. of Tech., Kanpur). Phys. Status Solidi (b); 49: No. 2, 761-8(1 Feb 1972).

Undoped KCl and KCl crystals doped with Co, Ba, and Cd were irradiated with x rays for various periods and bleached with F light at room temperature. The resulting decay of F centers and changes in the M- and R-center concentrations were studied. Co- and Ba-doped crystals x-irradiated into the second stage of coloration were found to exhibit, when compared to undoped crystals, (1) greater stability of F, M, and R-centers against F-light bleaching, and (2) higher F → M conversion efficiency. Cd-doped KCl showed a rapid bleaching of F centers without any increase in the M-center concentration. The role of impurities in the vacancy and electronic processes, which control the bleaching and aggregation of F-centers, is discussed. (auth)

Physical Properties

Refer also to abstracts 28554, 28555, 28577, 28604, 28623, 29440, 29467, and 29865.

30088 (AD-731828) TECHNOLOGY DEVELOPMENT FOR TRANSITION METAL-RARE EARTH HIGH-PERFORMANCE MAGNETIC MATERIALS. Semiannual Interim Technical Report No. 2, January 1-June 30, 1971. Becker, Joseph J. (General Electric Co., Schenectady, N. Y.). Jul 1971. Contract F33615-70-C-1626. 23p. (AFML-TR-71-178). NTIS.

The angular dependence of the behavior of magnetization reversal discontinuities in single-particle samples was studied in an effort to obtain more information about the nature of the imperfections responsible for the discontinuities. It was found possible to raise the coercive force of $Co_{17}Sm_2$, potentially a very high-performance permanent magnet material, by chemical treatment. Directionally solidified ingots of Co_5Sm were prepared for microscopic studies. While preferred growth transverse to the c-axis seems to predominate, one large grain near the beginning of the ingot showed a classic high-anisotropy transverse domain pattern. The minor impurities that might interfere with wet chemical analysis were identified. It was found that present processing techniques for sintered magnets do not substantially alter the composition of the starting material. Electron diffraction was used to identify the phases present in some sintered and heat-treated materials. Careful optimization of all processing procedures resulted in a Co-Sm magnet with an energy product of 23.4 mGOe, and Co-Pr-Sm magnets prepared from calcium-reduced oxide powders showed an energy product of 25 mGOe. Measurements of Br and of magnetization at various fields emphasize the importance of alignment in influencing magnetic properties. (auth) (USGRDR)

30089 (AECL-4133) DEPENDENCE OF THE INTEGRATED INTENSITY OF A SCATTERED NEUTRON GROUP ON THE EXPERIMENTAL CONDITIONS. Sears, V. F.; Dolling, G. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Jan 1972. 25p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

The accurate determination of phonon or magnon dispersion relations by inelastic neutron scattering with a triple-axis crystal spectrometer is facilitated by choosing scanning modes which give sharply focused scattered neutron groups. Since the optimum scanning mode is in general not a constant-$\vec{Q}$ mode, the integrated intensity of a group should be corrected for its dependence on the scanning mode before being used to determine, for example, the polarization vector of the phonon or magnon. The necessary correction factor is derived and discussed for a number of cases of practical interest. (auth)

30090 (BLG-460, pp 3,3-19) SOLID STATE PHYSICS. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 1970. 16p.

In Annual scientific report, 1970.

ALPHA PARTICLES—effects on tin and rhenium, annealing of
ARSENIC SYSTEMS—As-Cd-Ge, electronic properties of amorphous $CdGe_xAs_2$
—As-Se-Te-Tl, trapping level in amorphous $Tl_2SeAs_2Te_3$
ELECTRONS—effects on rhenium at 10 MeV, annealing of
HYDROGEN—energy levels of atomic, path-integral calculations of s-
LITHIUM NIOBATES—electric properties of $LiNbO_3$ single crystals
MERCURY ALLOYS—Hg-Mn, magnetic structure of Mn_2Hg_5
MOLYBDENUM—radiation damage in, annealing of neutron
NEUTRONS—effects on molybdenum and rhenium, annealing of
POLARONS—theoretical studies of
POTASSIUM IODIDES—KI-RbI, magnetic susceptibility of single crystals of
POTASSIUM MANGANESE FLUORIDES—exchange parameters from neutron scattering
RHENIUM—radiation damage in, annealing of alpha, electron, and neutron
TIN—radiation damage in, annealing of alpha (D.L.C.)

30091 (BMBW-FBK-71-15) STRUCTURE ANALYSIS BY THERMAL NEUTRON DIFFRACTION. Will, G.; Scharenberg, W.; Schaefer, W.; Bargouth, M. O.; Seidel, I. (Bonn Univ. (West Germany). Mineralogisches Institut). Oct 1971. 33p. (In German). Dep. NTIS (U. S. Sales Only).

Research activity on magnetic and crystal structures is reported. The twin neutron diffractometer and a new, unique low-temperature four-circle diffractometer for structure-factor measurements in the liquid helium temperature range are described. The following investigations are reported: 1) magnetic phase diagram of $Fe_2O_3-Cr_2O_3-Al_2O_3$; 2) antiferromagnetic structure of $CuSeO_4$; 3) antiferromagnetic structure of $DyVO_4$; 4) magnetic behavior of $ErFe_2$; 5) neutron diffraction measurements with Fe_2O_3 single crystals; and 6) crystal structure and Jahn–Teller distortion of $CuTa_2O_6$. (auth)

30092 ELECTRICAL RESISTIVITIES OF PYROLYTIC GRAPHITE. Saha, A. R.; Banerjee, P. K.; Das, A. K. (Jadavpur Univ., Calcutta). Indian J. Phys.; 44: No. 8, 438-44(Aug 1970).

A theoretical formulation of the problem of charge carrier transport in pyrolytic graphite is made and a criterion defined when a relaxation time approach for scattering (in addition to normal thermal scattering), originating at the intercrystalline boundary, is justified. Taking into consideration this additional scattering, the electrical resistivities (basal plane resistivity ρ_a, and c-axis resistive ρ_c) of pyrolytic graphite are deducible from single-crystal graphite transport parameters. Excellent agreement of the calculated values of resistivities with the experimental ones was found. (auth)

30093 ELECTRIC DISCHARGE IN RADIOACTIVE DIELECTRICS. Gromov, V. V.; Surikov, V. V. At. Energ. (USSR); 32: No. 2, 172-3(Feb 1972). (In Russian).

When samples containing radioactive isotopes are placed in a conducting medium, (e.g., ionized air), accumulated charges may be neutralized by current carriers in the surrounding medium. Experiments were conducted with samples of glass containing 30 mCi ^{90}Sr (in equilibrium with ^{90}Y) per gram of glass. A large electric charge was accumulated within the poorly conducting glass, and eventually led to a microrupture of the surface layers of the glass by discharge. (2 figures) (K.S.W.)

30094 FIELD-ION MICROSCOPY OF TUNGSTEN FOLLOWING VACUUM BREAKDOWN. Syutkin, N. N.; Vyatkin, N. N. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1564-6(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1979-82(Sep 1971).

The field-ion method was used to investigate the structure of a protuberance emitter formed as a result of vacuum breakdown. It is shown that the newly formed emitter has a perfect structure and that the observed bright and dark rings are functions of the shape of the micropoint. (auth)

30095 LATTICE STRAIN IN ION-BOMBARDED Si STUDIES BY X-RAY MOIRE TECHNIQUE. Gerward, L.; Christiansen, G.; Andersen, A. Lindegaard (Technical Univ. of Denmark, Lyngby). Phys. Lett.; 39A: No. 1, 63-4(10 Apr 1972).

Lateral strain produced by ion bombardment (Ar, 80 keV, 10^{15} ions/cm^2) of the analyzer crystal of a Si x-ray interferometer was investigated by the Moiré technique. A relative lattice expansion of (5 to 6) $\times 10^{-7}$ in the bombarded area was observed. (auth)

30096 ELECTRIC FIELD GRADIENT IN HEAVY RARE EARTH METALS. Pelzl, J. (Freie Univ., Berlin). Z. Phys.; 251: No. 1, 13-29(1972).

Estimates of the electric field gradient in heavy rare earth metals have been evaluated from experimental hyperfine interaction data. In addition, the magnetic hyperfine fields were analyzed. In the metals the effective radial integrals $\langle r^{-3}\rangle_{4f}$ of the magnetic and quadrupole hyperfine interaction were reduced at most by 10% compared with the free ion values. The electric field gradients due to the crystalline field have been found to be 200 times larger than those predicted from point charge calculations. This antishielding effect can be explained by an enhanced conduction electron density at the interstitial sites and an increase of the Sternheimer factor γ_∞ in the metallic environment. (auth)

30097 LAUE CASE OF X-RAY DIFFRACTION IN NEARLY PERFECT GERMANIUM CRYSTALS. Persson, E. (Chalmers Tekniska Hoegskola, Goteborg). Phys. Scr.; 3: No. 6, 293-301 (1971).

Measurements with a double-crystal spectrometer of the intensities of the x-ray beams transmitted and Laue-reflected through germanium single crystals at room temperature are presented. The 220 germanium reflection is used. The half-width and maximum reflecting power of rocking curves for 15 wavelengths between 0.497 and 2.290 Å and crystal thicknesses between 0.04 and 2.28 mm are given. The rocking curves calculated according to the dynamical theory of x-ray diffraction are in good agreement with those obtained experimentally. (auth) (Sweden)

30098 HALL EFFECT AND THE MAGNETORESISTANCE OF NITRIDES OF TITANIUM AND ZIRCONIUM. Malinskii, B. I.; Nemchenko, V. F.; L'vov, S. N. Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 3, 134-7(1971). (In Russian).

The Hall effect and the magnetoresistance ratio at room temperature and at liquid nitrogen temperature were determined for TiN and ZrN. The indicated ratio was 1.21 and 2.3, respectively. (K.S.W.)

30099 EXCHANGE INTERACTIONS IN $CeRu_2$ AND ITS MIXED CRYSTALS WITH RUTHENIDES OF OTHER RARE EARTH METALS. Hillenbrand, B.; Schuster, K.; Wilhelm, M. (Siemens AG, Erlangen, Ger.). Z. Naturforsch.; 26a: No. 10, 1684-91(Oct 1971). (In German).

With three methods, the effective exchange interaction was determined for $CeRu_2$ and its mixed crystals with ruthenides of other rare earth metals. The three methods were based on g-displacements, concentrations limiting the superconductive range, and Curie temperatures. The first two methods yielded effective exchange interactions of a few MeV; the third method gave significantly higher values. It was concluded that the small T_c-depression through magnetic ions of rare earth metals was caused by a small effective exchange interaction and not by interaction of ions with crystal fields. (tr-auth)

30100 THERMAL AND MAGNETIC STUDY OF THE CRYSTAL FIELD ENERGY LEVELS IN DILUTE RARE-EARTH ALLOYS. I. $Lu_{0.9035}Er_{0.0965}$. Taylor, W. A.; Gerstein, B. C.; Shickell, W. D.; Spedding, F. H. (Iowa State Univ., Ames). J. Chem. Phys.; 56: No. 6, 2722-30(15 Mar 1972).

The heat capacity from 6 to 300°K and initial susceptibility from 1.3 to 145°K of an $Lu_{1-x}Er_x$ alloy with x = 0.0965 were measured. The susceptibility indicated magnetic transitions at 2.3 and 10.3°K. The magnetic contribution to the heat capacity exhibited an anomaly at approximately 10.3°K along with a Schottky anomaly which is attributed to the crystal field levels of the Er in the alloy. In order to fit the high-temperature tail of the Schottky anomaly, the crystal field levels must have a total splitting of approximately 70 cm^{-1} with the levels bunched toward higher energies. (auth)

30101 PREPARATION OF NbO_2 SINGLE CRYSTALS BY CHEMICAL TRANSPORT REACTION. Sakata, Tamio (Max-Planck-Institut fuer Metallforschung, Stuttgart); Sakata, Kimiko; Hoefer, Gerhard; Horiuchi, Takashi. J. Cryst. Growth; 12: No. 2, 88-92(Feb 1972).

The preparation of NbO_2 single crystals was carried out by chemical transport using $TeCl_4$ as a transport agent. Well-formed octahedral crystals limited by faces of (101), (011) families were deposited on the cold zone. The crystal size was as large as 1 mm. Simultaneously, needle or platelet crystals were deposited on the colder zone. These crystals were identified to be an orthorhombic modification of $Nb_{12}O_{29}$. Their unit cell constants were determined to be a = 28.90 Å, b = 3.80 Å, c = 20.72 Å and their growth direction to be in the b-crystal axis. The necessity of buffering the oxygen partial pressure for the selective growth of either one of the crystals is described. The chemical transport of NbO was also tentatively made. (auth)

30102 LANTHANUM-STIMULATED HIGH-TEMPERATURE WHISKER GROWTH OF α-SiC. Verspui, G.; Knippenberg, W. F.; Bootsma, G. A. (Philips Research Labs., Eindhoven, Netherlands). J. Cryst. Growth; 12: No. 2, 97-105(Feb 1972).

A study has been made of the growth and morphology of α-SiC whiskers obtained by the effect of lanthanum on silicon carbide crystals growing into a cavity in a SiC mass, heated in an inert ambient of 1-atm pressure, at temperatures between 2300 and 2600°C. The morphology and the growth rates of the ribbon-like 6H whiskers were compared with the corresponding properties of the almost equilateral hexagon-shaped plane-parallel platelets of 6H SiC obtained in the same conditions, except for the presence of lanthanum. The addition of lanthanum caused the growth of thinner elongated crystals with an increased growth rate in the longitudinal direction and a decreased rate of growth in width. For platelets and ribbons the activation energies associated with the increase of the growth rates with increasing temperature were the same (~130 kcal/mole) for the two growth directions within experimental accuracy. Platelets and ribbons were both bounded by large-area basal faces {0001} and first-order prismatic and pyramidal side faces $\{10\bar{1}1\}$; the tips of whiskers interrupted in their growth were rounded and showed both first-order faces $\{10\bar{1}1\}$ and second order faces $\{11\bar{2}1\}$. The effect of lanthanum was understood as an ad-

sorption-blocking effect on the {10$\bar{1}$1} side faces favoring ao. {11$\bar{2}$1} faces of rapid growth at the tip of whiskers. (auth)

30103 COLD METAL CRUCIBLE SYSTEM FOR SYNTHESIS, ZONE REFINING, AND CZOCHRALSKI CRYSTAL GROWTH OF REFRACTORY METALS AND SEMICONDUCTORS. Oliver, D. W.; Brower, G. D.; Horn, F. H. (General Electric Research and Development Center, Schenectady, N. Y.). J. Cryst. Growth; 12: No. 2, 125-31(Feb 1972).

A cold metal crucible apparatus with induction heating was used for synthesis, purification, and growth of single crystals of refractory semiconductors and metals. The system is generally applicable without having to meet conditions of chemical compatibility between melt and crucible, and it can be used with an ambient at a pressure of a few atmospheres. The apparatus enables highly exothermic synthesis reactions to be controlled and simple phase-diagram studies to be conducted. (auth)

30104 HIGH-TEMPERATURE SOLUTION GROWTH OF SINGLE-CRYSTAL PLUTONIUM DIOXIDE. Finch, C. B.; Clark, G. W. (Oak Ridge National Lab., Tenn.). J. Cryst. Growth; 12: No. 2, 181-2(Feb 1972).

Macroscopic $^{239}PuO_2$ single crystals were grown from $Li_2O \cdot 2MoO_3$ solvent by a thermal-gradient technique at 1270 to 1300°C. Polycrystalline PuO_2 nutrient, on the floor of a tall, tightly closed platinum vessel at 1300°C, underwent transport upwards through 7 cm of PuO_2-saturated solution, whose upper surface was maintained at ~1270°C. Two-week runs resulted in the growth of octahedral crystals up to 2 × 3 × 3 mm in size, which formed on platinum substrates in the upper solution regions at 1270 to 1280°C. The growth rate for good-quality PuO_2 was ≤1 mm/week, and approximated that previously reported for the isostructural compounds CeO_2, ThO_2, and NpO_2 from similar solvents in this temperature range. Spectrochemical, lattice parameter, and oxygen analysis data indicated that the crystals are of good purity (>99.9%) and are near stoichiometry ($PuO_{1.97\pm0.03}$). (auth)

30105 PREPARATION OF In_2O_3 SINGLE-CRYSTALS VIA CHEMICAL TRANSPORT REACTION. De Wit, J. H. (State Unit., Utrecht). J. Cryst. Growth; 12: No. 2, 183-4(Feb 1972).

Octahedral In_2O_3 crystals with a volume of 1 mm^3 were grown from the vapor phase, using HCl as a transporting agent. The HCl pressure must be above a certain level; with low HCl pressures the crystal habit is changed. (auth)

30106 RESISTIVITY OF VANADIUM–OXYGEN ALLOYS. Starostina, L. S.; Maksimov, Yu. A. (Inst. of Crystallography, Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 11, 1581-3(Nov 1971).

Translated from Zh. Fiz. Khim.; 45: No. 11, 2789-91(Nov 1971).

The temperature variation of the resistivity of vanadium–oxygen specimens was investigated. A method is proposed for comparing the resistivities of specimens of arbitrary geometrical shape on the basis of the reciprocal of the derivative of the function $\rho(T)/\rho(273°K)$ with respect to temperature. (auth)

30107 MAGNETIC PROPERTIES OF Ni–Fe–Ta ALLOYS. Masumoto, Hakaru; Murakami, Yuetsu; Hinai, Masakatsu (Research Inst. of Electric and Magnetic Alloys, Sendai). J. Jap. Inst. Metals; 36: No. 1, 63-5(Jan 1972). (In Japanese).

Magnetic properties, electric conductivity, and hardness of vacuum-melted Ni–Fe–Ta alloys composed of 65.00 ~ 83.65% Ni, 8.00 ~ 24.70% Fe, and 3.20 ~ 23.90% Ta were measured when heated in pure hydrogen atmosphere at 1150°C for 3 hr and then cooled at various rates. The results showed that the addition of Ta brought about considerable improvements of these characteristics of Ni–Fe alloys. The highest values of 57,300 in initial permeability and 428,000 in maximum permeability were obtained on an alloy composed of 73.00% Ni, 12.05% Fe and 14.95% Ta when cooled from a temperature above the order–disorder transformation points at a rate of 800°C/hr. The coercive force and the intrinsic magnetic induction of the alloy were 0.0052 Oe (B_m = 5000 G) and 7420 G(H = 1000 Oe), respectively; its electric conductivity and Vickers hardness were 64.3 μΩ-cm and 197, respectively. (auth)

30108 PHONONS. International Conference Held in Rennes, France, July 26, 1971. Nusimovici, M. A. Paris; Flammarion Sciences (1971). 502p. (In French and English). (CONF-710723).

Eighty-six papers and nine abstracts are included on the following subjects: theoretical study of phonons in perfect crystals, phonons in ionic crystals; experimental study of phonons by inelastic scattering of neutrons and x rays; phonons in amorphous solids; phonons in molecular crystals; phonons in metals; acoustical phonons, elasticity, pressure effects, phase transition; phonons in imperfect crystals, and anharmonicity. A separate abstract was prepared for each of two papers. (TSS) (France)

For abstracts of individual papers see: 29424 and 30109.

30109 LATTICE DYNAMICS OF Cs_2UBr_6. Chodos, S. L. (Univ. of California, Los Angeles). pp 69-73 of Phonons. /Nusimovici, M. A. Paris; Flammarion Sciences (1971).

From International conference on phonons; Rennes, France (26 Jul 1971).

The results of a calculation of the phonon frequencies in cubic M_2XY_6 compounds are presented. Particular attention is given to Cs_2UBr_6, but the model is applicable to other materials of this structure. The model includes a Urey–Bradley valence force potential to describe the short-range interactions of the XY_6^{-2} complex, and also long-range Coulomb forces to describe the ionic nature of the crystal. Using single phonon energies obtained optically the force constants of the model were evaluated, and the phonon dispersion curves were calculated in the high symmetry directions. This calculation was motivated by the belief that such a model with only a few parameters would serve as a starting point for a comprehensive calculation of the vibronic structure of Cs_2UBr_6. (auth)

30110 LANTHANUM HEXABORIDE ELECTRON EMITTER. Ahmed, H.; Broers, A. N. (IBM Watson Research Center, Yorktown Heights, N. Y.). J. Appl. Phys.; 43: No. 5, 2185-92(May 1972).

The emitting properties of hot-pressed high-density lanthanum hexaboride rod cathodes were measured. A current density of 100 A/cm^2 is obtained at a true temperature of 1680°C. Lifetime tests have shown a useful life in excess of 200 h with an emission density of more than 50 A/cm^2. The initial buildup of emission from the cathode was found to be a gradual process and the final emission figures are not obtained until approximately 60 min have elapsed. Subsequently however, the full emission is obtained immediately on heating the cathode to operating temperature. The surface structure on the cathode was examined with a scanning electron microscope both during the initial buildup of emission and during the operating life of the cathode. It is found that surface evaporation reveals sharp crystalline boundaries at a stage which coincides with the full emission density from the cathode. On heating the cathode to operating temperature without drawing emission, the crystalline nature of the material is revealed by the appearance of faceted hillocks on the surface. This structure is etched away when emission is drawn. There is no evidence to support the theory that lanthanum evaporates from selected emission sites. The whole LaB_6 surface evaporates during operation and a certain amount of embedded material is revealed. This material is believed to contain tungsten and it accumulates gradually on the surface as operation continues. (auth)

30111 DISTRIBUTION OF AN IMPURITY IN A LiF SINGLE CRYSTAL AND THE DEPENDENCE OF THE THERMOLUMINESCENCE YIELD ON THE Ra CONCENTRATION. Bulgakov, V. B.; Shilov, A. M. (State Scientific-Research Inst. of Metrology, Novosibirsk, USSR). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 10, 1675-6(Oct 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 10, 1874-5(Oct 1971).

Annealed specimens of LiF with known radium contents were subjected to the gamma rays of a ^{60}Co source, and the thermoluminescence intensity was measured. Results show that the maximal thermoluminescence yield corresponds to minimal Ra concentration in the initial part of the crystal. With increasing Ra concentration in the crystal, the value of the thermoluminescence falls. However, there is evidently an optimal Ra concentration (less than 2×10^{-5} Ci/g) for which the thermoluminescence yield will be maximal. This is readily understood if it is assumed that the decrease in the impurity concentration in the crystal may not be accompanied by a constant increase of the thermoluminescence yield, because for a crystal with no Ra the thermoluminescence yield is 100 times less than a crystal with a Ra content of 2×10^{-5} Ci/g. (P.C.H.)

30112 SUPERCONDUCTIVITY AND RESIDUAL RESISTANCE OF TITANIUM CARBIDE. Neshpor, V. S.; Nikitin, V. P.; Novikov, V. I. (Inst. of Semiconductors, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 10, 1557-60(Oct 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 10, 1743-7(Oct 1971).

The electric conductivity of homogeneous titanium carbides of the composition $TiC_{0.91}$–$TiC_{0.46}$ was investigated. The temperature dependence of the electric resistance at 300 to 4.2°K was very weak, which showed that the resistivity at room temperature is due entirely to the residual resistance. The resistance and Hall coefficient decreased with carbon content of the TiC_x phases. At

a sufficiently high carbon defect concentration, the density of states near the Fermi level increased; the appearance of a superconducting gap in the energy spectrum may therefore be expected, owing to transition to the superconducting state only of homogeneous titanium carbides of the compositions $TiC_{0.52}$ and $TiC_{0.46}$. (auth)

30113 VARIABLE RESISTORS OF THE BULK TYPE BASED ON REFRACTORY COMPOUNDS. Samsonov, G. V.; Grebenkina, V. G.; Yusov, Yu. P.; Vlasov, L. G.; Perevezentsev, A. V. (Inst. of Problems in Materials Science, Kiev). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 10, 1575-8(Oct 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 10, 1764-8(Oct 1971).

The electrical properties of the refractories TiB_2, ZrB_2, CrB_2, W_2B_5, Cr_3C_2, TaC–WC, ZrC–WC, and $Cr_{0.05}Ge_{0.95}$ were investigated. Appropriate inorganic binders for refractory materials with optimum properties were found. The best resistive materials were found to be the complex carbides $Ta_{0.4}W_{0.6}C$ and $Zr_{0.7}W_{0.3}C$ in conjunction with lead–boron–barium glass. (auth)

30114 HIGH PRESSURE RESISTANCE MEASUREMENTS OF SOME LANTHANUM–CERIUM ALLOYS. King, E. (Atomic Energy Research Establishment, Harwell, Eng.); Harris, I. R. J. Less-Common Metals; 27: No. 1, 51-63(Apr 1972).

The room-temperature, high-pressure resistances of some La–Ce alloys were studied. The pressure of the resistance anomaly associated with the $\gamma \rightarrow \alpha$ phase change in pure cerium (fcc → fcc) increased smoothly with increasing lanthanum content from a value of 7 kB for cerium to about 25 kB for lanthanum. This suggests that the resistance anomaly in pure lanthanum could be associated with an electronic change similar to that observed in cerium, rather than due to the d.hex. → fcc structural change. The pressure at which the resistance anomaly associated with the $\alpha \rightarrow \alpha'$ change in cerium occurs increased rapidly with increasing lanthanum content and the magnitude of the effect decreased such that it could not be detected at above 40% lanthanum, indicating a possible critical point for this transformation. (auth)

30115 MAGNETIC PROPERTIES OF AMORPHOUS Fe_xGd_y ALLOY THIN FILMS. Orehotsky, J. (IBM Components Div., Hopewell Junction, N. Y.); Schroeder, K. J. Appl. Phys.; 43: No. 5, 2413-18(May 1972).

The magnetism of pure iron and gadolinium films, and of Fe_xGd_y alloy thin films with 15 to 94 at. % iron prepared by codeposition on a cold (77°K) substrate, were measured at 77°K and at room temperature. All the alloys had an amorphous structure that was stable to room temperature. The amorphous alloys were found to be ferromagnetic. The magnitude of the magnetization in rare-earth–transition-metal alloys does not appear to be structure-sensitive, since the magnetization of the amorphous alloys follows a linear concentration dependence calculated from an antiparallel coupling of the magnetic moments of crystalline iron and gadolinium. (auth)

30116 X-RAY PHOTOEMISSION BAND STRUCTURE OF SOME TRANSITION-METAL OXIDES. Wertheim, G. K.; Huefner, S. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Rev. Lett.; 28: No. 16, 1028-31(17 Apr 1972).

The valence-band structures of MnO, CoO, NiO, Cu_2O, CuO, and ReO_3 were obtained by x-ray photoemission spectroscopy. It was found that, in every case, a narrow metal d band lies above the center of the oxygen 2p valence band. (auth)

30117 MAGNETIC PROPERTIES OF UAsY COMPOUNDS (Y = S, Se, Te). Zygmunt, A.; Duczmal, M. (Inst. for Low Temperature and Structure Research, Wroclaw). Phys. Status Solidi (a); 9: No. 2, 659-63(16 Feb 1972).

Magnetic investigations were made of UAsY (Y = S, Se, Te) compounds obtained in the form of powder samples and single crystals within the temperature range 77 to 1000°K. It was ascertained that UAsTe displays a I4/mmm structure, while UAsS and UAsSe a P4/nmm structure. In the ordered range they can behave like ferri- (?) or ferromagnetics, their anisotropy is caused by the parallel arrangement of magnetic moments along the c-axis. The course of magnetic susceptibility was interpreted on the basis of qualitative calculations of the crystalline field effect of the $[UX_4Y_5]$ coordination polyhedron on the U^{4+} ion with the basic term $^3H_4$. (auth)

30118 HALL EFFECT, MAGNETIZATION, AND ELECTRIC RESISTANCE OF GADOLINIUM–YTTRIUM ALLOYS. Babushkina, N. A.; Mezentsev, V. V. Sov. Phys.-Solid State (Engl. Transl.); 13: No. 10, 2385-7(Apr 1972).

Translated from Fiz. Tverd. Tela; 13: No. 10, 2833-5(Oct 1971).

The electric resistance, Hall effect, and magnetization of Gd–Y alloys (with 100, 84, 72, 55, and 44 at.% Gd) were measured in the temperature interval 20 to 450°K. Up to concentrations of about 50 at.% Gd, the alloys remained ferromagnetic and had a complicated magnetic structure similar to that of pure Gd. It was observed that the ferromagnetic Hall effect in Gd–Y alloys (as well as the corresponding effect in pure Gd) results from the scattering of conduction electrons by inhomogeneities of the spin system. This is true for both changes of the spin system due to temperature changes and to yttrium concentration changes in the alloy. (auth)

30119 CALCULATION OF THE ELECTRON EMISSION PROBABILITY FROM DIELECTRICS IN THE CASE OF SECONDARY ELECTRON EMISSION AND THE EXTERNAL PHOTOEFFECT. Baksht, F. G.; Ivanov, V. G.; Moizhes, B. Ya. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 10, 2436-43(Apr 1972).

Translated from Fiz. Tverd. Tela; 13: No. 10, 2896-2905(Oct 1971).

In the case of secondary electron emission and the external photoeffect, electrons are mainly generated at distances which are considerably greater than the free path length and therefore the emission of excited electrons from a solid has a diffusive character. In the interaction between the electrons and the lattice, the electron characteristically loses a relatively small amount of its energy at each collision and so the movement of the electron during migration in energy space is also of a diffusive character. An equation for the two-dimensional diffusion in coordinate and energy is formulated and solved; hence, a function for the distribution of fast electrons is found. The probability of electron emission into vacuum from the solid is determined. (auth)

30120 POSITRON STATES IN IDEAL IONIC CRYSTALS. Gol'danskii, V. I.; Prokop'ev, E. P. (Inst. of Chemical Physics, Moscow). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 10, 2481-7(Apr 1972).

Translated from Fiz. Tverd. Tela; 13: No. 10, 2955-64(Oct 1971).

The effective-mass method is used to treat positron states (both quasipositronous and quasipositronic) in ideal ionic crystals. It is shown that annihilation of positrons in these states can explain all of the features of the positron annihilation process in ionic crystals. Earlier models of positron annihilation in ionic crystals are included in a natural way in the scheme presented. (auth)

30121 MAGNETIC BEHAVIOR OF U_3P_4 IN THE TEMPERATURE RANGE FROM 77 TO 300°K. Nasu, S. (Japan Atomic Energy Research Inst., Tokai). Phys. Status Solidi (a); 9: No. 2, 629-33(16 Feb 1972).

The magnetic properties of U_3P_4 were investigated in the temperature range from 77 to 300°K in various magnetic fields up to 10 kOe. Each magnetization versus temperature curve below field intensity of 6 kOe exhibited a peak that shifts to the lower-temperature side with increasing applied magnetic field. On the other hand, in case of cooling the sample through the Curie temperature in a magnetic field, there was no peak in the magnetization versus temperature curve. These behaviors seem to be associated with a high-anisotropy field below the Curie temperature. A large magnetic hysteresis effect at 77°K confirmed these arguments. The paramagnetic susceptibility obeyed the Curie–Weiss law, having a Weiss constant of 140°K and a paramagnetic moment of 2.76 BM. (auth)

30122 MAGNETIZATION AND EPR OF $GdAl_2$. Hacker, H. (Univ. of California, San Diego, La Jolla); Gupta, R.; Shepard, M L. Phys. Status Solidi (a); 9: No. 2, 601-6(16 Feb 1972).

A study of $GdAl_2$ is described in which emphasis was placed on the behavior of the magnetization in the vicinity of T_c and the EPR spectra with subsequent determination of the g-factor and linewidth by a programmable calculator curve-fitting technique. The Curie temperature was found to be (167.8 ± 0.6)°K from plots of σ^2 vs T, inflection points σ vs T, DTA thermograms, and the critical isotherm of σ^2 vs H/σ. Data on initial susceptibility are given in which $\chi^{-1} \sim (T - T_c)^{1.03}$. In the region $T > 200$°K, the appropriate Curie–Weiss law has the form $\chi_g^{-1} = 3.64_4 \times 10^{-2}/(T - 171)$. From the EPR spectra at 295°K, the g-factor was found to be 1.984_8 while the half-power linewidth was 1041 Oe. (auth)

30123 CRYSTAL STRUCTURE AND MAGNETIC AND ELECTRICAL PROPERTIES OF β-US_2. Suski, W.; Gibinski, T.; Wojakowski, A.; Czopnik, A. (Inst. for Low Temperature and Structure Research, Wroclaw). Phys. Status Solidi (a); 9: No. 2, 653-8(16 Feb 1972).

The crystal structure of β-US_2 was refined using single-crystal x-ray-diffraction data. The lattice constants at room temperature are: a = 8.4803 Å, b = 7.1139 Å, and c = 4.1205 Å. The uranium atom is coordinated by nine sulfur atoms: two at a dis-

tance of 2.713 Å, two at 2.896 Å, two at 3.141 Å, one at 2.747 Å, one at 2.826 Å, and one at 2.888 Å. The magnetic measurements were carried out in the temperature range 4.2 to 1000°K. The increase of the effective magnetic moment from 3.08 to 3.28 BM with temperature is explained on the assumption that the ground state is composed of four closely spaced singlets. The semiconducting character in the temperature range 4.2 to 650°K was established with a forbidden gap $\Delta E \approx 1.2$ eV. (auth)

30124 DIRECT MEASUREMENT OF THE TEMPERATURE COEFFICIENT OF SPECIFIC HEAT. Kraftmakher, Ya. A.; Tonaevskii, V. L. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Phys. Status Solidi (a); 9: No. 2, 573-9(16 Feb 1972).

A method of the direct measurement of the temperature coefficient of specific heat (TCSH), based on a modulation principle is proposed. The temperature dependence of the specific heat of a sample results in non-sine-like temperature oscillations, which are detected by the harmonic analysis. The measurements of the TCSH of tungsten from 2000 to 3600 K were in good agreement with the previously obtained specific heat data (Kraftmakher and Strelkov, Fiz. Tverd. Tela, 4: 2271(1962)) which were interpreted as related to the vacancy formation in a crystal lattice. The proposed method can be used for studying the point-defect formation in equilibrium and, possibly, for studying the specific-heat singularities at the second-order phase transitions. (auth)

30125 NEUTRON DIFFRACTION STUDY OF NONSTOICHIOMETRIC CERIUM HYDRIDE. Cheetham, A. K.; Fender, B. E. (Oxford Univ.). J. Phys., C (London); 5: No. 5, L35-40(Mar 1972).

$CeD_{2.0}$, $CeD_{2.15}$, and $CdD_{2.75}$ were examined by neutron diffraction. $CeD_{2.0}$ had the ideal fluorite structure. In both $CeD_{2.15}$ and $CeD_{2.75}$, interstitial deuterium atoms were displaced about 0.2 Å from the ½, ½, ½ position and there was evidence of a small concentration of normal deuterium vacancies. In $CeD_{2.15}$ there was an order–disorder transition near 300°K and $CeD_{2.75}$ that also showed long-range order at low temperatures. (auth)

30126 LOW-TEMPERATURE MAGNETIC SUSCEPTIBILITY OF GADOLINIUM AND TERBIUM TUNGSTEN OXIDE BRONZES. Shannon, Joseph R.; Sienko, M. J. (Cornell Univ., Ithaca, N. Y.). Inorg. Chem.; 11: No. 4, 906-7(Apr 1972).

$Gd_{0.15}WO_3$ and $Tb_{0.15}WO_3$ were prepared and their magnetic susceptibilities measured at 1.5 to 300°K. The reciprocal molar susceptibility vs temperature curves follow the Curie–Weiss law, with very small values of the Weiss parameter and excellent agreement between observed and calculated magnetic moments. This indicates that indirect exchange coupling does not occur, in contradiction to the results of W. Ostertag for uranium–tungsten bronze. (D.L.C.)

30127 CHARACTERISTIC ENERGY LOSS IN TRANSITION METALS. Korsunskii, M. I.; Genkin, Ya. E.; Zavodinskii, V. G. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 10, 2550-4(Apr 1972).

Translated from Fiz. Tverd. Tela; 13: No. 10, 3043-8(Oct 1971).

A model of collectivized local bonding and core electrons is used to examine the mechanism for energy loss by fast electrons to quasi-optical oscillations caused by a sublattice of locally bonding electrons. It is shown that an anisotropy in the quasi-optical oscillations may cause a nonlinear, somewhat logarithmic dependence of the height of the corresponding characteristic-loss peak on the energy of the fast electrons. The dependence of the plasma and quasi-optical oscillation frequencies on unidirectional compression of the crystal was studied. It turns out that the frequency of the quasi-optical oscillations changes some six to nine times more rapidly than the plasma frequency as the crystal is compressed. This phenomenon may be used for an experimental determination of the type of vibration on the basis of the energy-loss spectra. (auth)

30128 LATTICE DYNAMICS AND ELASTIC CONSTANTS OF HOLMIUM AND YTTRIUM. Menon, C. S.; Rao, R. Ramji (Indian Inst. of Tech., Kanpur). Phys. Status Solidi (b); 49: No. 2, 843-55(1 Feb 1972).

The lattice dynamics and elastic constants of the hexagonal metals holmium and yttrium were investigated using the approach of Keating. In holmium, the dispersion curves are fitted using eleven force constant parameters, and the six elastic constants are evaluated. The dispersion relations and the elastic constants of yttrium are fitted using twelve parameters. (auth)

30129 X-RAY PHOTOEMISSION STUDIES OF THE ELECTRONIC STRUCTURE OF RARE-EARTH METALS. Heden, P. O.; Loefgren, H.; Hagstroem, S. B. M. (Chalmers Univ. of Tech., Goteborg. Linkoeping Univ., Sweden). Phys. Status Solidi (b); 49: No. 2, 721-9(1 Feb 1972).

X-ray photoemission (XPS) measurements are reported on evaporated films of the rare earth metals Eu, Gd, and Yb. For comparison, additional measurements are reported on Ba. The results provide an unambiguous determination of the 4f energy levels. In Yb, the spin–orbit splitting is also clearly resolved. The locations of the 4f levels below the Fermi level are determined to be 2.1 eV for Eu, 7.7 eV for Gd, and 1.4 eV and 2.7 eV for Yb, all with an error of ±0.4 eV. (auth)

30130 INVESTIGATION OF THE STRUCTURE OF ENERGY BANDS USING QUASI-ELASTIC KNOCKOUT OF AN ELECTRON BY AN ELECTRON (e,2e). Levin, V. G.; Neudachin, V. G.; Smirnov, Yu. F. (Moscow State Univ.). Phys. Status Solidi (b); 49: No. 2, 489-98(1 Feb 1972).

The question of obtaining information on the band structure of solids using quasi-elastic knockout of an electron by an electron from a very thin crystalline film is discussed. It was found that Van Hove singularities practically have no effect on the quasi-elastic knockout cross section. Form factors for the bands Γ_1 Δ_1X_1, $\Gamma_{12}\Delta_1X_1'$, $\Gamma_1\Lambda_1L_1$, $\Gamma_{25}'\Lambda_1L_2'$ in a Cu single crystal were calculated. The shape of the form factors is very sensitive to the type of electron binding in a crystal and to the hybridization of states in a single-particle electron wave function. Form factors for a single crystal and a polycrystal of Al are also discussed. (auth)

30131 NEUTRON-DIFFRACTION STUDY OF THE MAGNETIC STRUCTURE OF Mn_3B_4. Neov, S. (Inst. of Physics, Sofia); Legrand, E. Phys. Status Solidi (b); 49: No. 2, 589-96 (1 Feb 1972).

From neutron-diffraction measurements it is concluded that below the Néel temperature of 392°K the intermetallic compound Mn_3B_4 becomes antiferromagnetic. At this stage only the Mn(2c) atoms are magnetic. Below 226°K the Mn(4g) atoms also become magnetically ordered and deform the collinear antiferromagnetic structure to a spiral structure, with an angle of 157.5°, which at lower temperature gradually develops to a collinear antiferromagnetic structure again. The saturated magnetic moments are 2.92 μ_B for the Mn(2c) atoms and 0.44 μ_B for the Mn(4g) atoms. (auth)

30132 ON THE DETERMINATION OF THE FERMI SURFACE AND SCATTERING PROPERTIES OF NIOBIUM BY MEASUREMENTS OF MAGNETORESISTANCE. Lehmann, G. (Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Dresden); Kutscherenko, J. N. Phys. Status Solidi (b); 49: No. 2, K205-8(1 Feb 1972).

Details of the Fermi surface and the scattering process in pure Nb single crystals were obtained from transverse magnetoresistance measurements. The minimum diameter $d(\varphi_m)$ of the neck between Γ and H was found to be 0.216 (ΓH), with $d(0) = 0.202$(ΓH), the curvature $a = 0.825\ (\Gamma H)^{-1}$, $f = 0.343$ (ΓH), overlapping $b = 0.068$ (ΓH). Spikes must exist around the two-dimensional regions near the [100] and [111] directions, and only a singular point existe near the [110] direction. (D.L.C.)

Moessbauer Effects and NMR

Refer also to abstracts 29661, 29743, and 29767.

30133 (CONF-720414–1) EXPERIMENTAL SPIN DENSITIES. Moon, R. M. (Oak Ridge National Lab., Tenn.). Mar 1972. 38p. Dep. NTIS.

From American Crystallographic Association meeting; Albuquerque, N. M. (4 Apr 1972).

The use of neutrons for investigating the behavior of outer electrons in magnetic materials is discussed. Differences in the role of neutrons in determining spin densities and that of x rays in determining charge densities are compared. Various experimental techniques that have been used in the study of magnetic neutron scattering are reviewed. The materials used include Gd_2O_3, Fe, Ni, and Co. (45 References). (P.C.H.)

30134 NUCLEAR AND SOLID-STATE PHYSICAL INVESTIGATIONS USING THE MOESSBAUER EFFECT IN ^{157}Gd. Goering, Juergen (Technische Hochschule, Darmstadt, Ger.). Z. Phys.; 251: No. 3, 185-94(1972). (In German).

With the narrow line of the 64-keV γ ray in ^{157}Gd, the isomer shift, magnetic field, and electric field gradient in Gd metal were precisely determined precisely. The ratio of the g-factors of the excited state and the ground state was measured, from which the magnetic moment of the excited state was deduced. Comparisons to theoretical and other experimental results are performed. From the isomer shift, a value of $\delta\langle r^2\rangle$ can be inferred. (auth)

30135 MOESSBAUER MEASUREMENTS OF NEPTUNIUM(VII) COMPOUNDS. Froehlich, Klaus (Technische Hochschule, Darmstadt, Ger.); Guetlich, Philipp; Keller, Cornelius. Angew. Chem. Int. Ed. Eng.; 11: No. 1, 57-8(Jan 1972).

^{237}Np Moessbauer measurements were made on Li_5NpO_6, $[Co(en)_3]NpO_5 \cdot \times H_2O$, $Ba_3(NpO_5)_2 \cdot \times H_2O$, and $Ca_3(NpO_5)_2 \cdot \times H_2O$ at 4.2°K, using ^{241}Am in Th as source. Isomer shifts, quadrupole splittings, and asymmetry parameters were measured. All the isomer shifts were more negative than that of NpF_6, indicating a greater electron density at the Np nucleus. The NpO_6^{-5} in Li_5NpO_6 has probably the shape of a compressed octahedron. The Np–O bond lengths in the other three compounds are shorter than in Li_5NpO_6, and the common anion formed by all three compounds is $[NpO_4(OH)_2]^{3-}$ and not NpO_5^{3-}. The structure consistent with the Moessbauer results is described. (D.L.C.)

30136 INVESTIGATION OF RADIATION DAMAGE BY MICROSCOPIC METHODS. Christiansen, J. (Univ., Erlangen, Ger.). Atomkernenergie; 19: No. 2, 161-6(Apr 1972). (In German).

Hyperfine interactions of excited nuclei are used to investigate the nearest neighborhood of ions implanted into solid-state material by nuclear reactions. Information concerning the static electromagnetic field situation around the implanted nuclei is obtained via the nuclear reaction $^{56}Fe(d,p)^{57}Fe$ in ferromagnetic material using the Moessbauer effect. Relaxation processes of aligned nuclei are studied by means of perturbed angular-correlation techniques with excited nuclear states. Effects of radiation-induced dislocations in solids can be interpreted with a diffusion-controlled time-dependent quadrupole interaction. (auth)

Theory

Refer also to abstract 29960.

30137 (COO–3161–65) EVAPORATION OF COLD METALLIC HYDROGEN. Salpeter, E. E. (Cornell Univ., Ithaca, N. Y.). Jan 1972. Contract AT(11-1)-3161. 11p. Dep. NTIS.

Solid metallic hydrogen is metastable only at low pressures, but the transition to the molecular form may require surface phenomena. The "evaporation" of pairs of adjacent surface atoms (forming free H_2^- molecules) is discussed. A monolayer of surface atoms is lost in e^G times a lattice vibration period, where $G \lesssim 20$ at zero pressure and temperature. G increases with pressure and decreases with temperature above $T_c \sim 150°K$. (auth)

30138 (LBL–432) BEHAVIOR OF INELASTIC ELECTRONS. Tan, Teh Yu (California Univ., Berkeley. Lawrence Berkeley Lab.). Jan 1972. Contract W-7405-eng-48. 158p. Dep. NTIS. Thesis.

Certain aspects of the behavior of electrons after they become inelastic in a crystal are investigated. Inelastic electrons carry information such as image and characteristic loss spectrum of the specimen. In a diffraction pattern, they also form line and band intensity distributions known as Kikuchi patterns. A theory, which is applicable to calculations of both Kikuchi profiles and images formed by inelastic electrons, is formulated in terms of Bloch waves for which absorptions of both elastic and inelastic electrons are considered. Analytical solution of the problem of Kikuchi intensity distributions for a four-beam case (two elastic and two inelastic beams) is obtained. It is shown that the following aspects of the behavior of the Kikuchi pattern are explained: (1) the formation of the Kikuchi line pair, (2) the formation of the Kikuchi band and its changes in intensity from excess to deficient, (3) the Kikuchi line contrast reversal, and (4) the variations of the Kikuchi line spacing with specimen thickness. Consideration of a systematic many-beam case for a thick crystal shows that for this case the Kikuchi pattern may be simply calculated from sums of rocking curve intensities. The design and operational schematics of an energy analyzing microscope constructed at Berkeley is given. It is thought that the applicability of this technique to microanalysis of local chemical constitutions of a crystal specimen by analyzing variations in plasmon loss spectrum is limited to Al-based alloys. A review of the dynamical theory of (elastic) electron diffraction in crystals, which forms the necessary background knowledge of this study, is given in the appendix. Solutions of the many-beam and image problems are formulated in terms of the dispersion matrix. Methods for calculating this matrix are given. (auth)

30139 GROUND-STATE CALCULATIONS FOR SOLID HYDROGEN AND DEUTERIUM. Mertens, Franz Georg (Institut fuer Theoretische Physik, Aachen). Z. Phys.; 250: No. 1, 1-13(1972).

The ground-state energy, the mean square displacement of the molecules, the lattice constant, and the effective quadrupole–quadrupole coupling constant are calculated variationally and compared with the experiments. Both the orientationally ordered fcc and hcp phases are considered. Nosanow's cluster expansion is used and its convergence is discussed. (auth)

30140 MAGNETIC FIELD INFLUENCE ON THE INDIRECT RUDERMAN–KITTEL–KASUYA–YOSIDA INTERACTION. Kolodziejczak, A. (Technical Univ., Wroclaw). Acta Phys. Pol.; A41: No. 1, 51-5(Jan 1972).

A new method for calculating the correction to the RKKY interaction due to the presence of magnetic field is presented. This correction turns out to be small, but for some cases can be significant. (auth)

PHYSICS (THEORETICAL)

Refer also to abstracts 28735, 29115, 29322, 29323, 29938, 30156, and 30161.

30141 (ITF-71-84-P) TWO-TIME TEMPERATURE FORMALISM IN THE THEORY OF NORMAL FERMI-SYSTEMS. III. QUASIPARTICLE EXCITATIONS IN THE LOW TEMPERATURE SYSTEM. Ozrin, V. D.; Kvasnikov, I. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 103p. (In Russian). Dep. NTIS (U. S. Sales Only).

The Bogolyubov-type equations are used to obtain a one-particle Green function for degenerate normal Fermi system in two cases: low-density gas with short-range interaction and high-density electron gas. The approximation is made in the equation describing the regular part of the two-particle Green function. Asymptotic corrections related with corresponding small parameters are retained. The commutation-type two-particle Green functions for solution of the problem are considered. Peculiarities of the low-energy quasi-particle excitations, as well as regions of their existence and their attenuation, were investigated. (auth)

30142 EXPERIMENTAL TEST OF LOCAL HIDDEN-VARIABLE THEORIES. Freedman, Stuart J.; Clauser, John F. (Univ. of California, Berkeley). Phys. Rev. Lett.; 28: No. 14, 938-41(3 Apr 1972).

The linear polarization correlation of the photons emitted in an atomic cascade of calcium was measured. It has been shown by a generalization of Bell's inequality that the existence of local hidden variables imposes restrictions on this correlation in conflict with the predictions of quantum mechanics. The data, in agreement with quantum mechanics, violate these restrictions to high statistical accuracy; this result provides strong evidence against local hidden-variable theories. (auth)

30143 MATRIX EQUATIONS OF QUANTUM MECHANICS. Eckstein, S. G. (Argonne National Lab., Ill.); Varga, B. B.; Aks, S. Nuovo Cim.; 8B: No. 2, 451-60(11 Apr 1972).

A widely discussed paradox in quantum mechanics is due to the failure of the matrices representing linear operators to satisfy the algebraic relations of the operators. Several examples involving boundary conditions on the domains of differential operators show how these failures arise, and sufficient conditions are given to prevent them. It is found that in certain cases the time-dependence of the matrix elements of an observable should be calculated via the commutator of the infinite matrices of the observable and the Hamiltonian, and not in terms of the formal commutator of these operators. (auth)

30144 NEW FORMULATION OF THE QUANTUM-MECHANICAL ANALOG OF THE WIENER-KHINTCHINE THEOREM FOR ELECTROMAGNETIC FIELDS. Carusotto, S. (Univ., Pisa, Italy). Nuovo Cim.; 8B: No. 2, 289-306(11 Apr 1972).

A new formulation of the quantum-mechanical analog of the Wiener–Khintchine theorem is presented. It is shown that for the radiation fields with null unpaired second-order correlation tensors and with the modes arbitrarily correlated, the trace of the paired second-order correlation tensor between two arbitrary times t_1 and t_2 at the space point r and the spectral energy density at the space-time point $[r, (t_1 + t_2)/2]$ form a Fourier-transform pair. The condition of cross-spectral purity is briefly discussed for fields obeying the new formulation of the Wiener–Khintchine theorem. (auth)

30145 CALCULATION OF TIME DEPENDENT CORRELATION FUNCTIONS IN INTERACTING SPIN SYSTEMS. Winter, J. M. (CEN de Saclay, Gif-sur-Yvette, France). Ann. Phys. (Paris); 6: No. 3, 167-86(Jun 1971). (In French).

The methods developed by Resibois and co-workers for calculating the time dependent spin correlation functions are discussed. The kinetic equation is established by a different diagrammatic method. The results of the calculation for various types of interactions are discussed, especially in the high temperature region and the critical region. (France)

30146 DISTRIBUTION OF EIGENFREQUENCIES FOR THE WAVE EQUATION IN A FINITE DOMAIN. III. EIGENFREQUENCY DENSITY OSCILLATIONS. Balian, R.; Bloch, C. (CEN, Saclay, France). Ann. Phys. (N. Y.); 69: No. 1, 76-160(Jan 1972).

The oscillations that appear in the smoothed density of eigenvalues when the smoothing width is relatively small are considered. The existence of these oscillations is demonstrated by evaluating exactly the smoothed eigenvalue density for simple shapes of the volume; flat parallelepiped, sphere. A general theory of the density oscillations is then developed on the basis of the time-independent Green function formalism. An asymptotic evaluation of the various terms of the multiple reflection expansion is carried out by means of the principle of stationary phase, or by means of a contour integration method. A systematic investigation of the various resulting contributions shows that the dominant oscillations are associated with the closed classical trajectories, i.e., the closed polygons having their vertices on the boundary surface S and such that mirror reflections on S take place at each vertex. Various possible geometrical configurations of these closed paths are discussed—degenerate, accidentally degenerate, repeated paths. Several cases of cancellations between various contributions are indicated. In the case of the parallelepiped, it is easy to compare the expansion given by the present theory with the exact density. The case of the sphere is discussed numerically, in order to determine the number of terms of the expansion which are actually necessary to reproduce the exact distribution of eigenvalues. In view of practical applications, detailed expressions are given for axially symmetrical surfaces. The contour integration method is applied to an axially symmetrical surface having a complex stationary path. Finally, density oscillations are discussed and interpreted in terms of the semi-classical picture. (auth)

30147 VARIATIONAL CALCULATION OF THE EXCHANGE ENERGY OF AN INHOMOGENEOUS ELECTRON GAS AND THE EFFECTIVE ASSOCIATED EXCHANGE POTENTIAL. Dagens, L. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). J. Phys. (Paris); 32: No. 10, 719-28(Oct 1971). (In French).

An approximation is established for the exchange energy E_x and the associated exchange potential V_x applicable to the conduction electrons of a simple metal. The general formulation of Kohn and Sham, which enables an exact calculation of the total Hartree–Fock energy (HF), and the magnitude of the derivatives, to be made from a Hartree–Fock–Slater type equation, is presented. It is shown that E_x may be calculated using an original variational method and that this calculation verifies an inequality which enables the upper limit to be determined. The method is applied in the framework of the quasi-free electron approximation and leads to the $X_1(q)$ approxfmation of the exact effective exchange interaction X(q). The static dielectric constant $\epsilon_1(q)$ associated with X_1 is identical with the interpolation formula proposed by Geldart and Taylor. A certain number of properties verified by X(q) are established: $X_1(q)$ is the rigorous upper limit of X(q), the static dielectric constant $\epsilon_1(q)$ is less than or equal to the true HF value: $\epsilon_{HF}(q)$. The X_1 approximation is exact when $q \to 0$ or $q \to$ infinite, and presents a very pronounced minimum when q is approximately equal to 1.9. The true X(q) function presents an analogous minimum. (France)

30148 HYDRODYNAMICAL MODEL OF WAVE MECHANICS. VII. STERN-GERLACH EFFECT OF THE H ATOM. Janossy, L. (Central Research Inst. of Physics, Budapest). Acta Phys. Acad. Sci. Hung.; 30: No. 2, 131-7(1971).

It is shown that treating the Stern–Gerlach effect as a one-body wave mechanical problem—i.e. supposing the nucleus to behave classically—the treatment leads to an incorrect classical result. The splitting of the beam is only obtained in the many-body treatment. (auth)

30149 HYDRODYNAMICAL MODEL OF WAVE MECHANICS. VIII. SOME LIMITATIONS OF THE ONE-BODY TREATMENT. Janossy, L. (Central Research Inst. of Physics, Budapest). Acta Phys. Acad. Sci. Hung.; 30: No. 2, 139-43(1971).

As was shown previously the quantum mechanical treatment of the Stern–Gerlach effect of the H-atom leads to an incorrect result if it is treated as a one-body problem. It is shown by further examples that the characteristic quantum mechanical results are obtained only when considering many body problems in wave mechanics. The schematized treatment of certain problems as one-body problems leads to classical results. (auth)

30150 HAMILTONIAN FORMALISM FOR GENERAL LAGRANGIAN SYSTEMS IN AN EXCEPTIONAL CASE. Ryan, C. (Univ. of Alberta, Edmonton. University Coll., Dublin). J. Math. Phys. (N. Y.); 13: No. 3, 283-5(Mar 1972).

It is shown that in the exceptional case of a Lagrangian system, where the highest derivative of a generalized coordinate cannot be expressed in terms of the lower derivatives and the generalized momenta, the procedure to adopt in setting up the Hamiltonian formalism for the system (and consequently the quantization of the system) is to pass to an equivalent Lagrangian which does not have this defect and to use this rather than the original Lagrangian. (auth)

30151 EXCITATION OF A TWO-LEVEL SYSTEM DAMPED BY INTERACTION WITH BOSONS. I. Loos, J. (Inst. of Solid State Physics, Prague). Czech. J. Phys.; 21: No. 11, 1123-35(1971).

The transition probabilities of a two-level system interacting with a certain boson field are considered. The probability of the induced transition and the total probability of the transition from the initial state (decay of the initial state) are determined supposing the excitation of the system by the monochromatic classical field. The calculations are carried out following the general theory presented by W. Heitler (The Quantum Theory of Radiation, Oxford–New York 1954) using the first approximation with respect to the damping. The time dependences of transition probabilities are discussed in terms of parameters characterizing the rate of the excitation and of the damping. (auth)

30152 ORIGIN OF EXCHANGE INTERACTIONS. Larsen, Ulf (Oersted Inst., Copenhagen). Amer. J. Phys.; 40: No. 1, 100-8(Jan 1972).

Although it is well known that the exchange interaction is a basic property of Fermi systems, the available derivations of this interaction usually involve special assumptions that tend to obscure its origin. A more general derivation free from these assumptions is presented. It is shown that this derivation leads directly to the diagrammatic representation of perturbation theory first used by Hugenholtz. The s–d exchange Hamiltonian of Kasuya is derived as a special case for systems with localized states. (auth)

30153 CLASS OF INFINITE PRODUCTS OCCURRING IN QUANTUM STATISTICAL MECHANICS. Fano, G. (Univ., Bologna); Loupias, G. Ann. Inst. Henri Poincare, Sect. A; 15: No. 2, 91-106(1971).

The class of infinite products $f_c^{\frac{1}{2}}(\lambda) = \sum_{n=0}^{\infty} a_n^{\frac{1}{2}} \lambda^n = \prod_{j=1}^{\infty}(1 + \lambda c(k_j)^2)$, $k_j = j(2\pi/L)$ and $L \epsilon R^+$, $c(k) = (A/k^m)$, $k \geq 0$, $A > 0$, $m > \frac{1}{2}$, is studied where it occurs naturally in statistical mechanics. In particular, the limits limit $(a_{n+1}^{\frac{1}{2}}/a_n^{\frac{1}{2}})$ and limit $(1/L)$ Log $a_n^{\frac{1}{2}}$ which $\lim_{n\to\infty}\left|\frac{2n}{L}\right| = d$ $\lim_{n\to\infty}\left|\frac{2n}{L}\right| = d$ are relevant in the problem of the thermodynamic limit of the BCS superconducting state are computed. In this way, new results concerning the infinite products of the form $\lim_{n\to\infty} n^{1/\rho}(b_{n+1}/b_n)$ and $\lim_{n\to\infty}$ (1/2n) Log $n^{1/\rho} b_n^{1/n}$ are obtained. In particular, the limits $g_\rho(\mu) = \sum_{n=0}^{\infty} b_n \mu^n = \prod_{j=1}^{\infty}[1 + \mu(A/j^{1/\rho})]$, $A > 0$, $0 < \rho < 1$ are computed. (France)

30154 LEAST SQUARES SOLUTION OF THE SCHROEDINGER EQUATION BY A MONTE CARLO METHOD. Allen, T. L. (Indiana Univ., Bloomington. Univ. of Nottingham, Eng. Univ. of California, Davis). Chem. Phys. Lett.; 13: No. 5, 504-6 (1 Apr 1972).

The importance sampling method is applied to the least squares solution of the Schroedinger equation, using the spherical Gaussian orbital to select points. Application to the helium atom gives good results with relatively few points. (auth)

30155 GENERALIZATION OF THE CONCEPT OF INVARIANCE OF DIFFERENTIAL EQUATIONS. RESULTS OF APPLICATIONS TO SOME SCHROEDINGER EQUATIONS. Anderson, Robert L.; Kumei, Sukeyuki; Wulfman, Carl E. (Univ. of the Pacific, Stockton, Calif.). Phys. Rev. Lett.; 28: No. 15, 988-91(10 Apr 1972).

It was found that differential equations can be form invariant under a larger class of infinitesimal transformations than those considered by Lie and Ovsjannikov. A generalization of the concept of point transformation is given. It is necessary for the systematic determination of the generators of continuous invariance groups of, e.g., the partial differential equations of physics. Applying it to Schrödinger's equation, time-dependent constants of the motion are found systematically, as illustrated here for the hydrogen atom. (auth)

30156 STRONGER FORM FOR THE POSITION–MOMENTUM UNCERTAINTY RELATION. de la Pena-Auerbach, L.; Cetto, A. M. (London Univ.). Phys. Lett.; 39A: No. 1, 65-6(10 Apr 1972).

A stronger and more general form of the position-momentum uncertainty relation is derived on the basis of stochastic theory; this new relation applies equally well to classical stochastic and quantum-mechanical systems. (auth)

30157 CANCELLATION EFFECT AMONG n-BODY CLUSTERS IN LIQUID ^{3}He AND NUCLEAR MATTER. Rajaraman, R.; Trehan, R. K. (Univ. of Delhi). Phys. Rev., A; 5: No. 1, 392-6 (Jan 1972).

A simple combinatorial theorem regarding the cancellation between direct and exchange many-body clusters in liquid ^{3}He is proven. Under certain simplifying assumptions, the result would mean that all n-body clusters cancel each other for $n \geq 3$. Deviations of the real ^{3}He system from these simplifying assumptions are also discussed. Corresponding statements are made throughout for the nuclear-matter system as well. (auth)

30158 ROBINSON–TRAUTMANN SOLUTIONS ON COMPACT MANIFOLDS. Porter, J. R.; Thompson, A. H. (Univ. of Pittsburgh). Lett. Nuovo Cim.; 3: No. 12, 481-2(18 Mar 1972).

The proposition is put forth that global Robinson–Trautmann type II or D-solutions on compact manifolds do not exist. In particular, it is noted that the existence of a global Schwarzschild vacuum solution on a compact manifold is precluded. (L.B.S.)

30159 DERIVATION OF THE HARTREE–FOCK EQUATIONS. Mayer, I. (Central Research Inst. for Chemistry, Budapest). Acta Phys. Acad. Sci. Hung.; 30: No. 4, 373-9(1971).

A simple general derivation of the Hartree–Fock equations is given. The derivation is based on the Brillouin theorem which is proved in its most general form for a Slater determinant built up from not necessarily orthogonal spin orbitals. The Hartree–Fock equations can be obtained as a specific formulation of the Brillouin theorem for the case of orthogonal spin orbitals. (auth)

30160 ENTROPIC CHANGES IN A MEASURED QUANTUM-MECHANICAL OBJECT. Majernik, V. (Inst. of Physics, Bratislava). Acta Phys. Acad. Sci. Hung.; 30: No. 4, 389-97(1971).

The processes connected with the entropy of measured quantum mechanical objects are investigated. The entropic characteristics of the measurement process are determined by means of the so-called entropy balance. It is shown that the Shannon entropy of quantal objects described by noncommutative operators is always positive in the post-measurement state. From the entropy balance of quantum mechanical measurement also follows that the measurement of the characteristics of quantal objects provides some information on quantities not measured. (auth)

30161 TRACE OF THE PRODUCT OF PAULI AND DIRAC MATRICES. Sarkar, S. (Indian Association for the Cultivation of Science, Jadavpur, India). Acta Phys. Acad. Sci. Hung.; 30: No. 4, 351-64(1971).

Several methods for the determination of the trace of the product of an arbitrary number of Pauli matrices are established. Formulas are derived for the evaluation of various types of products of two traces when terms of the type $\sigma_{i1}\sigma_{i2} \ldots \sigma_{in}$ occur in both of them. Expressions are found for the product of two different traces and the square of the trace of an arbitrary number of Pauli matrices. Similar formulas are obtained when Dirac matrices occurring as $\sum_{i=1}^{5} \gamma_i A_i$ are considered instead of Pauli matrices. From this all previous results in which γ_5 has been considered separately are recovered. A useful identity for traces involving either Pauli or Dirac matrices is given. (auth)

30162 STATES, MINIMIZING THE UNCERTAINTY PRODUCT OF THE OSCILLATOR PHASE OPERATORS. Ifantis, Evangelos K. (Democritus Nuclear Research Center, Athens). J. Math. Phys. (N. Y.); 13: No. 4, 568-75(Apr 1972).

The normalizable states that minimize the uncertainty product of the oscillator phase operators are determined, and some of their physical properties are discussed. A physical classification of these states is made, and the class of "analogous" states to the well-known coherent states is physically defined. (auth)

30163 DYNAMICAL QUANTIZATION. Onofri, E.; Pauri, M. (Univ., Parma, Italy. Istituto Nazionale di Fisica Nucleare, Milan). J. Math. Phys. (N. Y.); 13: No. 4, 533-43(Apr 1972).

An intrinsic quantization procedure based on higher symmetries of classical dynamical systems and utilizing the techniques of van Hove and Souriau is proposed. The procedure is intrinsically Hamiltonian but not explicitly canonical in that the Heisenberg algebra plays no fundamental role. The proposed method is applied to the n-dimensional harmonic oscillator and to the n-dimensional hydrogen atom. This approach seems to provide the first intrinsic justification of the success of ordinary correspondential quantization for this last system. (auth)

30164 EXACT AND SIMULTANEOUS MEASUREMENTS. Deliyannis, Platon C. (Illinois Inst. of Tech., Chicago). J. Math. Phys. (N. Y.); 13: No. 4, 474-7(Apr 1972).

The observables which can be determined through their states of exact measurement are characterized, and a criterion for the set of states in which two observables are both measured exactly is established so that the two observables will be compatible. (auth)

REACTOR TECHNOLOGY

Power Reactor Development

Refer also to abstract 28537.

30165 (AAEC/E-223) SOME GEOMETRICAL PROPERTIES OF PACKINGS OF EQUAL SPHERES IN CYLINDRICAL VESSELS. PART IV. EXTENSION OF MODEL TO OUTER REGION OF SEMI-INFINITE VESSEL WITH PLANE WALL. Tingate, G. A. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Oct 1971. 44p. Dep. NTIS (U. S. Sales Only).

A range of random packings was prepared in a prismatic vessel with a plane vertical transparent wall, simulating a semi-infinite vessel. Observations were made in the outer region of the packings. The three-dimensional model previously presented was extended to the outer region of unbiased packings in such a vessel. Equations from Part III are used, together with some of the properties of the regular arrays not previously considered. The rhombohedral and cubic arrays are shown to be members of a family of regular arrays, some of whose properties agree closely with experimentally determined properties of unbiased random packings over the range normally obtained in practice. The model is also shown to be in fair agreement with observed properties in the outer region of the loosest random packings prepared in the laboratory, enabling estimates to be made of some of their properties in the central region. The two-dimensional model presented in Part III was also extended to the outer region, and the computed results are supported by a limited experimental study. (auth)

30166 (BLG-460, pp 1.1-38) DEVELOPMENT OF FAST REACTORS. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 1970.
In Annual scientific report, 1970.

BELGIAN REACTOR-2—experimental facilities of, summary of 1970 operation of
REACTOR FUEL ELEMENTS—reprocessing of fast, development program for
REACTOR FUELS—development of carbide and mixed oxide fast, program for
REACTORS, FAST—development during 1970, Belgian program for
SODIUM—properties of reactor coolant, loop measurements of (H.D.R.)

30167 (BLG-460, pp 2.1-35) DEVELOPMENT OF THERMAL REACTORS. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 1970.
In Annual scientific report, 1970.

BELGIAN REACTOR-3—core for, operation of Vulcain mock-up
PLUTONIUM—recycling in thermal reactor fuels, program for
REACTOR FUELS—development of thermal, program for
—development of plutonium containing, for thermal reactors
REACTORS, THERMAL—development during 1970, Belgian program for
VULCAIN MARITIME REACTOR—core for, operation of mock-up (H.D.R.)

30168 (RDT-INDEX-3-72) INDEX OF RDT STANDARDS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Mar 1972. 24p. RSO.

30169 (RDT-Status-3-72) RDT STANDARDS TRANSMITTAL. Bimonthly Status Report of RDT Standards for Period Ending March 31, 1972. (Oak Ridge National Lab., Tenn.). 40p. RSO.

30170 DEVELOPMENT OF POWER REACTORS IN THE UNITED KINGDOM. Stewart, J. C. C. (British Nuclear Design and Construction Ltd., Whetstone, Eng.). pp 1.1-11 of Engineering for Nuclear Power. /Stewart, J. C. C. Nottingham, Eng.; Univ. of Nottingham (1971).

A review of the present industrial standing of nuclear power is given together with a short account of the basic physical processes involved in the generation of electric power from uranium. The historical background to the development of nuclear power in the UK is presented, starting from the military program of the immediate post war years and evolving with the first White Paper of February 1955. Some of the reasons and the course of events which led to the selection of gas cooling for the first generation of power stations and then the development of a water-cooled reactor are presented. An attempt is made to focus the reasons for the course of the development of this field of engineering science. Future developments and in particular the need to fully utilize uranium resources are discussed. (auth) (UK)

30171 ENGINEERING OF GAS-COOLED THERMAL REACTORS. Seymour, D. F. (British Nuclear Design and Construction Ltd., Whetstone, Eng.). pp 2.1-25 of Engineering for Nuclear Power. /Stewart, J. C. C. Nottingham, Eng.; Univ. of Nottingham (1971).

The main features of some of the gas-cooled, thermal reactors in operation, under construction or under consideration in the UK are described, together with some of the reasons for their selection. (auth) (UK)

30172 ENGINEERING OF WATER-COOLED THERMAL REACTORS. Brown, Gordon (British Nuclear Design and Construction Ltd., Whetstone, Eng.). pp 3.1-47 of Engineering for Nuclear Power. /Stewart, J. C. C. Nottingham, Eng.; Univ. of Nottingham (1971).

In the USA two different systems evolved, the Boiling Water Reactor (BWR) operating in a direct cycle, and the Pressurized Water Reactor (PWR) operating in an indirect cycle. In the mid-1950s, Britain evolved the Steam Generating Heavy Water Reactor, which is a pressure tube system using D_2O as moderator and H_2O as coolant in a direct cycle. The engineering of these systems is dealt with in detail, with emphasis on the PWR and the SGHWR. Consideration is given to the reactors and their components, conventional plant, safety features, and control. (auth) (UK)

30173 ENGINEERING OF FAST REACTORS. Wolff, P. H. W. (British Nuclear Design and Construction Ltd., Whetstone, Eng.). pp 4.1-34 of Engineering for Nuclear Power. /Stewart, J. C. C. Nottingham, Eng.; Univ. of Nottingham (1971).

Fast reactor development is described and analyzed, and brief descriptions are given of some major fast reactor installations and their contribution to the present state of knowledge. The engineering of the major facilities in the United Kingdom fast reactor development program is given in some detail. Reference is made to future plans and also to fast reactor systems making use of coolants other than sodium. (auth) (UK)

30174 SITUATION AND GROWTH OF NUCLEAR POWER. Bechtel, Hanns (Metallgesellschaft AG, Frankfurt am Main). Metallges., Mitt. Arbeitsbereich; No. 13, 37-40(1970). (In German).

A report is given on the situation of the requirements and supplies of energy in the world, the USA, and the FRG. The different sources of energy are considered, particularly the costs of energy and electricity. (INIS)

30175 BREEDER REACTORS. . Denielou, Guy Centre d'Etudes Nucleaires de Cadarache, Saint-Paul-les-Durance, France); Estavoyer, Michel; Fonteray, P. J.; Gajac, Georges; Villeneuve, Jean. Ind. At.; 15: No. 5, 61-7(Nov 1971). (In French).

The situation concerning fast reactors in the world and the problems to be solved before they reach the commercialization stage are described. (France)

30176 NUCLEAR POWER: CURRENT QUESTIONS AND FUTURE PLANS. Gimstedt, Olle. Sv. Kraftverksfoeren. Publ.; No. 9, 217-48(1970). (In Swedish).

A table of the existing power reactors in operation and nuclear construction is presented together with commentaries. Information is given about manufacturers of power reactors. A description of the technical status of different types of reactors is given. Operation experience, accessibility and operation costs are analyzed for a number of power reactors. (Sweden)

30177 500 MWth SPHERICAL PILE REACTOR FOR PROCESS HEAT WITH ONE-WAY CHARGE. Maly, V.; Schulten, R.; Teuchert, E. (Kernforschungsanlage, Juelich, Ger.). Atomwirt., Atomtech.; 17: No. 4, 216-20(Apr 1972). (In German).

Based on the one-way charge principle, the spherical pile reactor continuously receives new fuel element spheres from the top. During burnup, the spheres slowly sink toward the discharge installation at the bottom of the core. The cooling gas, too, flows through the reactor from top to bottom. In the lower hot region, the spheres show small power production and temperature gradients. Because of this fact, the one-way charge principle is suit-

able for obtaining high exit temperatures of gases at relatively high average power densities of the reactor. (tr-auth)

30178 ENLIGHTENED NUCLEAR INDUSTRY IN JAPAN. Tokyo; Denki Taimusu (1971). 380p. (In Japanese).

Nuclear energy promises the country a stabilized energy supply at relatively low cost in the long-range future. Although somewhat behind other more advanced countries, development of nuclear power is being realized, as seen in the construction of one after another nuclear power station. Activities in the fields of nuclear energy in Japan are described in the following: reactor plants, nuclear fuels, nuclear power generation, facilities and radiation applications, multi-purpose reactors, and the atomic energy policy. (Japan)

30179 NUCLEAR POWER PLANTS USING LIGHT WATER. Toureau, Pierre (Electricite de France, Paris). Ind. At.; 15: No. 5, 39-50(Nov 1971). (In French and English).

Light water reactors (both boiling and pressurized types) are at present favored by all electricity producers because of their simplicity and reliability. The short term future seems assured by the development of breeder reactors. Present reactors produce the Pu fuel which will be used in these reactors. (France)

30180 REACTOR TECHNOLOGY. VOLUME 15, NUMBER 1. One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Washington, D. C.; Atomic Energy Commission (Spring 1972). 86p. $0.75.

Included are 4 articles on reactor design, materials, and licensing. A separate abstract was prepared for each of the articles. (H.D.R.)

For abstracts of individual papers see: 30181, 30188, 30224, and 30364.

30181 WEAR AND FRICTION CHARACTERISTICS OF STRUCTURAL MATERIALS IN LIQUID SODIUM. Glaeser, W. A. (Battelle Memorial Inst., Columbus, Ohio). Reactor Technol.; 15: No. 1, 1-10(Spring 1972).

A review of current friction and wear technology in sodium-cooled reactors indicates that excessive wear and high friction constitute design problems. Selection of materials and determination of safe load levels on the basis of friction- or wear-failure criteria are based on data from tests in which contact conditions are closely simulated. Current wear theory must be applied both in establishing test parameters and in applying test data to design. The surface chemistry of molybdenum-, chromium-, and tungsten-containing alloys is an important factor in sliding contact in sodium environment. (17 references) (auth)

30182 OPTIMIZATION STUDIES FOR A CIRENE REACTOR SYSTEM. PART I. BASIC CRITERIA AND CALCULATION PROCEDURES. Bozzola, S.; Lombardi, C.; Pedrocchi, E.; Zorzoli, G. B. (CISE, Milan). Energ. Nucl. (Milan); 19: No. 4, 236-50(Apr 1972).

After a short description of a CIRENE reactor system, the basic criteria adopted for the optimization studies, such as constraints and optimization parameters, are discussed. Then a survey of the main design criteria follows. The last section is devoted to a discussion of the cost evaluation procedures. (16 references) (auth)

30183 PRESENT STATUS OF NUCLEAR ENERGY AND ITS MULTIPLE UTILIZATION (SUBGROUPS 2.4 AND 3.6). Neumann, J. C. (McKinsey and Co., Inc., Duesseldorf). Brennst.-Waerme-Kraft; 24: No. 2, 53-7(Feb 1972). (In German).

Summarized are presentations of the subgroups 2.4 through 3.6 given at the eighth world energy conference at Bucharest. Discussed are: future energy requirements and supply of fissionable material; type strategy in nuclear programs; reactor concepts and their further development; and multiple utilization of nuclear energy. (H.B.G.)

30184 INCENTIVES FOR THE DEVELOPMENT OF THE FAST BREEDER REACTOR. Murphy, P. M.; Palmer, R. S.; Sherer, D. B. Pub. Util. Fortn.; 89: No. 7, 25-30(30 Mar 1972).

The development of the sodium-cooled fast breeder reactor is the highest priority nuclear power program in each of the major industrialized countries of the world. Discussed are: (1) computer model assumptions; (2) model calculations; (3) market effects with—and without—breeder reactors; (4) uranium consumption results; (5) critical requirements for commercial breeders; and (6) effects of time delay. (auth)

Physics and Core Engineering

30185 ANALYSIS OF He GAS COOLED FAST BREEDER REACTOR. Mochizuki, Hiroji; Tanaka, Ryokichi; Izaki, Takashi; Takitani, Koichi; Ooka, Toshitaka (Kawasaki Heavy Industries, Ltd., Kobe, Japan). FAPIG (Tokyo); No. 62, 70-7(Aug 1971). (In Japanese).

An outline is presented of analyses on nuclear and thermal performance of core and fuel cycle cost, and of selection of core parameters carried out for a 1000 MW(e) He gas cooled fast breeder reactor. Fuel rod diameter, core height and fraction of He gas passage area as representative factors of channel geometry were treated as design parameters, and their effects on the nuclear and thermal performance of initial core and burnup characteristics were examined. The burnup characteristics are calculated one-dimensionally and two-dimensionally on refueling scheme of two batches as well as one batch. This analysis showed feasibility of the He gas cooled fast breeder reactor using oxide fuel, with fissile inventory of 2500 kg and doubling time of 9 years. (Japan)

30186 PRESENT STATUS OF DESIGN OF FAST BREEDER REACTORS. Ohtake, Iwao; Yoshimi, Hirotaka (Fuji Electric Co. Ltd., Tokyo). FAPIG (Tokyo); No. 61, 58-69(Aug 1971). (In Japanese).

The development of FBR in foreign countries is described. The development of FBR in U.S.S.R., the United Kingdom, France, Western Germany and U.S.A. respectively, which have been made under individual conditions of economic structure, potential capability, and international position, is reviewed. Technical standpoints of component design for the reactors are analyzed. (Japan)

30187 HEAT TRANSFER AS A LIMITING FACTOR IN WATER COOLED NUCLEAR REACTORS. Kjaerheim, G. (Institutt for Atomenergi, Halden, Norway). pp 244-88 of Advanced Course on Limiting Aspects of Fuel Element Performance in Water Cooled Power Reactors. Kjeller, Norway; Instituut for Atomenergi (1971).

Heat ratings of 800–900 W/cm visualized for advanced fuel designs will place high demands on the heat removal capability of the coolant. The various convective boiling regimes are described and the causes of DNB (departure from nucleate boiling) in both a BWR and a PWR are given. The consequences of operating beyond critical heat transfer conditions and the burnout mechanism are discussed. The burnout correlations of Becker, of Barnett, of Janssen and Levy and the Westinghouse W-3 correlation are described, and the technique of burnout prediction discussed and examples quoted. A brief evaluation of the economic factors involved is given in conclusion. (Norway)

30188 ENDF/B-2: IS IT ADEQUATE FOR THE DESIGN AND EVALUATION NEEDS OF THE LMFBR PROGRAM? Alter, Harry (Atomics International, Canoga Park, Calif.). Reactor Technol.; 15: No. 1, 59-75(Spring 1972).

Integral parameters for a series of fast reactor bench-mark assemblies, covering a wide range of energy spectra, were calculated with the reference cross-section set ENDF/B-2. Multigroup constants, relative to each assembly, were generated and used in S_n transport and/or diffusion-theory calculations to obtain the parameters. These included k_{eff}, spectral indices (activation ratios), and central reactivity worths. Results of the several calculations indicate that the neutron cross-section data for such fuel-material isotopes as ^{235}U, ^{238}U, and ^{239}Pu on the reference set ENDF/B-2 do not give satisfactory agreement with measured values of the parameters. (50 references) (auth)

30189 MEASUREMENT OF THE TEMPERATURE DEPENDENCE OF k_∞ FOR A $^{233}UO_2-ThO_2$ HIGH TEMPERATURE GAS-COOLED REACTOR LATTICE. Lippincott, E. P. (Battelle-Northwest, Richland, Wash.). Nucl. Sci. Eng.; 47: No. 4, 475-83 (Apr 1972).

The second in a series of experiments using the High Temperature Lattice Test Reactor was completed and provides information on the temperature dependence of k_∞ for a $^{233}UO_2-^{232}ThO_2-C$ fuel mixture. The infinite medium multiplication factor was found to decrease by 0.0350 ± 0.0015 from 20 to 1000°C. This result provides direct information necessary in the design of the control system and in the safety analysis for advanced high temperature gas cooled reactors. (18 references) (auth)

30190 EFFECT OF THE TIME DEPENDENCE OF FISSION PRODUCT CROSS SECTIONS IN FAST REACTORS. Schenter, R. E.; Bunch, W. L.; Little, W. W. (Hanford Engineering Develop-

ment Lab., Richland, Wash.). Nucl. Sci. Eng.; 47: No. 4, 471-2(Apr 1972).

The effect of the time dependence of fission product cross sections on reactivity calculations for large $(Pu,U)O_2$ fueled fast reactors is examined. It is found that this effect is quite small for both operation and shutdown time intervals. (auth)

Control and Instrumentation

Refer also to abstract 28693.

30191 DEVICE FOR CONTROLLING THE REACTIVITY OF NUCLEAR REACTORS. Braun, Wolfgang (to Siemens Aktiengesellschaft). U. S. Patent 3,652,394. 28 Mar 1972. Priority date 23 May 1969, Germany.

A device is described for controlling the reactivity of a nuclear reactor cooled by light water. The reactor core is formed of fuel elements, and a tube system passing through the reactor core. The tube system is transversed by a water-soluble neutron absorber of adjustable concentration. The system includes a plurality of substantially vertically extending fingerlike tubes always fully inserted in the fuel elements; a spiderlike holder holding the fingerlike tubes together at the upper ends serves as distributor for the neutron absorber to the fingerlike tubes. A holder rod extending from the spiderlike distributor serves as a central supply line for the neutron absorber to the spiderlike distributor. (auth)

30192 TECHNICAL REQUIREMENTS IN PROCESS COMPUTERS FOR REACTOR SAFETY. Floh, W. (Technischer Ueberwachungsverein Bayern eV, Munich). Atomwirt., Atomtech.; 17: No. 4, 223-6(Apr 1972). (In German).

Process computers occupy a solid place in modern nuclear power plants. Their operations range from data accumulation and evaluation to process control. Process computers appear sufficiently developed for utilization in reactor safety. In the BRD, their installation is planned for several nuclear power plants under construction. Discussed are fundamental problems of safety techniques such as time behavior, independence of redundant measuring channels, ease of monitoring, and vulnerability. (tr-auth)

Containment Systems, Waste Processing, and Radiation Protection

Refer also to abstract 28144.

30193 (ANL-7911) COMPARISON OF A TWO-DIMENSIONAL HYDRODYNAMICS CODE (REXCO) TO EXCURSION EXPERIMENTS FOR FAST REACTOR CONTAINMENT. Ash, J. E.; Julke, R. T. (Argonne National Lab., Ill.). Jan 1972. Contract W-31-109-eng-38. 80p. Dep. NTIS.

The Reactor Excursion Containment Code System (REXCO) is a tool that has been developed to predict the effects of excursions originating at the core upon the components and on the containment system of Liquid Metal Fast Breeder Reactors. The codes include hydrodynamic and inelastic material behavior depending on the magnitude of the excursion treated. The physical phenomena gaged by the codes involve the shock wave, the sodium momentum, and the early stages of the gas bubble. Current work attempts to extend treatment to the later, quasi-steady phenomena of the gas bubble. Comparisons of these codes are made with experimental excursion data. The results of these comparisons confirm the capability of the REXCO code system to predict the response of the primary-system components and of containment structures to the generated pressure waves. The primary-system phenomena extend, but are not limited, to reactor-vessel strain and rupture, plug jump, and sodium escape past the cover seal into the secondary containment. The validating comparisons were made with published experimental data. 12 references. (auth)

30194 (ORNL-TM-3448) ENERGY SUPPRESSION AND FISSION PRODUCT TRANSPORT IN PRESSURE-SUPPRESSION POOLS. Stanford, L. E.; Webster, C. C. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 60p. Dep. NTIS.

A facility was constructed and operated in which steam (with a given iodine concentration) could be discharged through single or multiple downcomers under the surface of a water pool (with a given iodine concentration). Experimental data were obtained in this facility for various parameters of interest on both the suppression of steam by the pool and the removal of iodine by and from the pool during the blowdown interval. Pressure-suppression experiments were performed involving steam mass velocities up to 4.6×10^5 lb hr^{-1} ft^{-2} and pool water temperatures up to 140°F, and with single and multiple downcomers up to 2 in. nominal pipe size. Data from these experiments fit the relationship: the ratio of the length of the steam jet to the diameter of the injection pipe (L/D) is proportional to the natural logarithm of the mass velocity of the steam. The effects of water temperature, air in the steam, and dissolved air in the pool water all had a significant effect on the resulting suppression phenomenon. These factors are also of considerable importance in the analysis of fission product transport in pressure-suppression pools. Iodine concentrations in the pool water (from 0.5 to 10 ppM) and in the cover gas over the pool water were determined as a function of time for given steam flow rates, blowdown mixtures, and initial water conditions. The greatest iodine carryover to the cover gas was less than 2% in the cases tested. When 2 wt % air was mixed with the steam, the iodine carry-over was increased by a factor of 4 or greater compared with pure steam in nondegassed water. Results from these tests, coupled with knowledge of the pressure-suppression process, permitted the formulation of a first-order analytical method that appears promising for calculation of fission product transport to the pool surface. 88 references. (auth)

30195 (ORNL-TM-3695) FAST REACTOR SHIELDING MONTHLY PROGRESS REPORT FOR DECEMBER 1971. 189A NO. 10028, ACTIVITY NO. 40 01 61. Mynatt, F. R.; Gritzner, M. L.; Maerker, R. E.; McGregor, B. J. (Oak Ridge National Lab., Tenn.). 31 Jan 1972. Contract W-7405-eng-26. 50p. Dep. NTIS.

FAST TEST REACTOR—shielding for, neutron flux distribution in, (E)
LIQUID METAL FAST BREEDER REACTOR—coolant for, neutron transport through liquid sodium, (E)
NEUTRONS—flux distribution in liquid metal cooled fast reactor shielding, (E)
—transport through liquid sodium, (E)
SHIELDING—neutron flux distribution in liquid metal cooled fast reactor, (E)
SODIUM—neutron transport through liquid, (E) (D.C.C.)

30196 (TID-25962) SAFETY GUIDE 19: NONDESTRUCTIVE EXAMINATION OF PRIMARY CONTAINMENT LINERS. [Division of Reactor Standards (AEC), Washington, D. C.]. 29 Dec 1971. 8p. USAEC.

Nondestructive methods to examine the welds in the liners and penetrations of reactor containments of concrete construction are described. (H.D.R.)

30197 CRITERIA FOR REINFORCED CONCRETE NUCLEAR POWER CONTAINMENT STRUCTURES. Title No. 69-2. Detroit; American Concrete Institute (1971). 26p.

These design criteria are to serve as a guide in the design of reinforced concrete nuclear power containment structures. The philosophy of these structures in general is presented. The various factors to be considered in the design are outlined. Specific information on design and analysis methods, on load factors, and on allowable stresses and strains is included. The special material requirements pertaining to the construction of nuclear structures, such as ductility, splices, prestressing, corrosion protection, and others are described. The special requirements of documentation and testing, such as preservation of records, performance of leak tests, and weld inspections, etc., are listed. (auth)

30198 NUCLEAR REACTOR CONTAINMENT SYSTEM. Yedidia, Joseph M.; Reichelsdorfer, Peter W.; Dorrycott, Joseph W.; Russell, James G. (to Westinghouse Electric Corp.). U. S. Patent 3,649,451. 14 Mar 1972. Filed 23 Sep 1968.

A nuclear reactor containment system is described wherein a nuclear reactor vessel is supported within a normally dry well and means are provided for flooding the dry well to protect the nuclear core against melt down in the event of a vessel failure. A first quantity of coolant fluid, for example, borated water, is provided to fill the dry well to a level beneath the vessel, and a second quantity of coolant fluid, which may be obtained from condensed primary coolant that had been lost through a rupture in the primary system, is utilized to fill the dry well to a sufficient level to protect the nuclear core. (auth)

30199 IMPROVEMENTS IN OR RELATING TO THE CONDENSATION OF CONTAMINATED STEAM DURING ACCIDENTS TO NUCLEAR REACTORS. Henrici, Helmut; Lehmer, Wilhelm (to Linde Aktiengesellschaft). British Patent 1,266,722. 15 Mar 1972. Priority date 30 Apr 1968, Germany.

CONDENSERS—design of tubular ice, arranged in mesh grids

REACTOR CONTAINMENT SYSTEMS—design of ice condenser, with tubular ice arranged in mesh grids
REACTORS, POWER—containment system for, with tubular ice arranged in mesh grids (H.D.R.)

30200 EXPERIMENT ON THE MEASUREMENT OF LEAK IN ACTIVATED CHARCOAL FILTER SYSTEMS USING FLON (R-112). Ikezawa, Yoshio (Japan Atomic Energy Research Inst., Tokai); Kitani, Susumu; Yoshida, Yoshikazu; Kozuka, Masao; Takeda, Hayato. Nippon Genshiryoku Gakkaishi; 14: No. 3, 106-12(Mar 1972). (In Japanese).

An experimental study was performed to obtain fundamental data for in situ tests of activated charcoal filters installed in reactor exhaust systems using "R-112" as a tracer. The results show that leakage flows less than 0.1% by channelings around gasket seals and the defects caused by settling in activated charcoal filters could be evaluated by analyzing the "R-112" adsorption efficiency curves. Moreover, it was found that the very high adsorption of "R-112" tracer on activated charcoal (more than 99.995%) was not affected by in situ test conditions such as temperature, humidity, flow velocity. These results agreed with those determined by the theoretical calculation, assuming that mass transfer through a gas film was the controlling factor in adsorption of "R-112" by activated charcoal. (14 references) (auth)

Coolant System

Refer also to abstract 28290.

30201 (ANL-7846) SODIUM TECHNOLOGY QUARTERLY REPORT, APRIL-JUNE 1971. Kesser, G. M. (comp. and ed.) (Argonne National Lab., Ill.). Oct 1971. Contract W-31-109-eng-38. 59p. Dep. NTIS.

The research, development, and management efforts are reported for the period April–June 1971. In the national meter program, RDT standards relating to impurity meters and meter modules are prepared and coordination of the national effort to produce a standardized electrochemical oxygen meter is continuing. The development of on-line meters for carbon and hydrogen and leak detectors for steam generators, and design and testing of meter modules for FFTF are described. In the analytical standards program, RDT standards relating to purity specifications for sodium and cover gas are prepared; laboratory work includes development of a method for separating particulates from sodium, modification of the oxyacidic flux method for determination of carbon in sodium, studies of segregation of radioactive species in reactor sodium, and standardization and testing of a method for determining oxygen activity in sodium by equilibration of vanadium wires. Development work is described for a method for detecting ^{135}I in reactor sodium by separation and counting of its daughter ^{135m}Xe and for methods for relating the data to characterization of fuel failures. Studies of the chemistry of liquid sodium are directed toward examination of vacuum distillation as a means of determining oxygen, hydrogen, and nitrogen in sodium and to the determination of the solubility of krypton in liquid sodium. Studies on the transport of carbon in sodium-steel systems and on the development of a method for determining the activity of carbon in sodium by equilibration of metal specimens are described. (auth)

30202 (BNWL-SA-4051) WHY CORROSION PRODUCTS MUST BE CONTROLLED IN POWER PLANT WATERS. Demmitt, T. F.; Johnson, A. B. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 10 Dec 1971. Contract AT(45-1)-1830. 8p. (CONF-720305-1). Dep. NTIS.

From International corrosion conference; St. Louis, Mo. (30 Mar 1972).

The reduction of corrosion processes in water cooled power reactor cooling systems is discussed. The effects of corrosion on reactor performance are analyzed. Methods for reducing the corrosion are described. (4 references) (D.C.C.)

30203 APPARATUS FOR INCREASING POWER DENSITY IN A BOILING LIQUID NUCLEAR REACTOR. Knox, William M. (to United States Atomic Energy Commission). U. S. Patent 3,629,065. 21 Dec 1971. Filed 23 Jul 1969.

The power output of a boiling liquid reactor is increased by providing means for forming a vortex within the boiling zone of coolant channels. (Official Gazette)

30204 COOLANT GAS CIRCULATING BLOWERS FOR GAS COOLED REACTORS. Teruya, Hitoshi (Ebara Mfg. Co. Ltd., Tokyo). FAPIG (Tokyo); No. 61, 14-18(May 1971). (In Japanese).

The type, structure, drivers and problems of gas circulators installed in primary circuit of AGRs and HTGRs are described. As temperature and pressure of reactor gas become higher, the gas circulators running at high speed in the primary circuit require higher reliability and safety. Marked differences of these gas circulators now being developed are related with shaft sealing techniques. One method is by adoption of traditional shaft seal, while the other method is submerged structure without shaft seal of the gas circulator. (Japan)

30205 LIQUID COOLANT INSTALLATION FOR A NUCLEAR REACTOR. Lileg, Johann; Reif, Kurt (to Maschinenfabrik Aktiengesellschaft). U. S. Patent 3,651,866. 28 Mar 1972. Priority date 30 Jul 1968, Austria.

A main pump is incorporated in a liquid coolant circulation system. A drive shaft extends from the main pump and is operable to cause the main pump to circulate liquid coolant in the system. A shaft seal surrounds the shaft and is arranged to permit liquid to leak from the system when liquid coolant circulates. A purifier unit is adapted to receive the leakage liquid and to purify the same by removing solid particles therefrom and to discharge purified leakage liquid to the circulation system. (auth)

30206 SOME PROBLEMS OF HYDRO- AND AERO-ELASTICITY. Conference Held at Paris, France, March 18, 1971. Houille Blanche; 26: No. 6, 491-571(1971). (In French). (CONF-710347).

Separate abstracts are presented for four of the eleven papers presented. Information is presented concerning the effects of liquid sodium flow hydraulics on component vibrations in the Phenix Fast Reactor. (D.C.C.)

For abstracts of individual papers see: 30207–30209 and 30222.

30207 VIBRATORY BEHAVIOR OF THE INTERMEDIATE EXCHANGERS OF THE PHENIX REACTOR. Andro, J. (Societe Stein Industrie, Paris); Boulot, F.; Kayser, G. Houille Blanche; 26: No. 6, 491-8(1971). (In French).

From Meeting on some problems of hydro- and aeroelasticity; Paris, France (18 Mar 1971).

The methods used to investigate intermediate heat exchanger tube vibrations in the Phenix reactor, due to the primary circuit sodium flow, are described. Two different approaches are made to the problem, one by calculation, comparing natural and possible excitation frequencies, and the other an experimental approach using a model intended for purely hydraulic research. The limitations of each method are described and it is shown that resonance cannot occur. (France)

30208 EXPERIMENTAL STUDY OF THE FLUCTUATING HYDRODYNAMIC FORCES IN THE PHENIX REACTOR. Lambert, P.; Leon, P. (Societe Grenobloise d'Etudes et d'Applications Hydrauliques, Grenoble, France). Houille Blanche; 26: No. 6, 499-503(1971). (In French).

From Meeting on some problems of hydro- and aeroelasticity; Paris, France (18 Mar 1971).

A scale model was used to study the vibrations affecting the tanks and submerged components of the Phenix reactor, the fluctuating hydrodynamic forces being measured. Some of the exciting hydraulic forces in the structures could not be represented by the simulated method. Such forces were determined by measuring pressure fluctuations at different points in the structure during flow. The random pressure fluctuations were analyzed in order to determine the direct and crossed energy density spectra together with the appropriate correlation factors from which the maximum vibration amplitudes could be determined. (France)

30209 RESPONSE OF CYLINDRICAL SHELLS TO HYDRODYNAMIC EXCITATION. Levin, L. (Societe BVS, Grenoble, France); Milan, D.; Payan, G. Houille Blanche; 26: No. 6, 505-12(1971). (In French).

From Meeting on some problems of hydro- and aeroelasticity; Paris, France (18 Mar 1971).

The Phenix reactor is used to illustrate a method of investigating the response of certain cylindrical structures to the random pressure fluctuations resulting from turbulent fluid flow. The excitations were determined using a hydraulic model and the vibratory characteristics were determined from the overall behavior of a mechanical model. It is shown how current random shell vibration theory can be used to calculate the response. Formulas giving two upper response limits are easily derived as the excita-

tion power spectrum density is constant over the shell surface considered and simple to express mathematically. (France)

Fuels and Fuel Elements

Refer also to abstracts 27973, 30406, and 30413.

30210 (AED-CONF-71-100-31) NEW HIGH-TEMPERATURE REACTOR CONCEPT FOR THORIUM CONVERSION. Hansen, U.; Maly, V.; Teuchert, E. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). May 1971. 16p. (CONF-710901-527). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The new "Once Through" loading scheme of the pebble-bed reactor is a highly simplified reactor system with great flexibility in lay-out and fuel cycle optimization. It is extremely well suited for the adaption of an economical $^{232}Th-^{233}U$-cycle because of the wide range of variation in operation characteristics and fuel element design. The elements are graphite spheres of 6 cm diameter containing the fuel in coated particles. In the conventional pebble-bed type they are continuously circulating until a burnup measurement sorts them out. In the "Once Through" system, however, the speed of the balls is slowed down so much that they reach their final burnup after only one irradiation period which makes a burnup measurement superfluous. The fuel management scheme allows the use of several types of elements (feed-breed-concept) being loaded, mixed or separated into different core regions (multi-zones lay-out). This new type is characterized by the fact that the fresh fuel is concentrated in the upper part of the core which causes a very strong flux tilt in the upper half. The downward flow of the cooling gas prevents the temperature in the high power fuel elements to exceed the technological limits. In the lower core the fuel is depleted and a moderate heat transfer allows the increase of the average gas outlet temperature to 950°C or more. In the thorium cycle, the delayed production of ^{233}U causes a certain axial flattening of the fissile distribution which improves the fuel utilization. The use of uranium as a feed fuel in the thorium cycle requires adequate fuel element design and loading schemes, and the calculational model has to follow the reactor life history. Combined with the advantages of the flexible fuel management, the new concept yields a system of great simplicity and economy for the thorium conversion. (auth)

30211 (AED-CONF-71-100-32) THORIUM IN HEAVY WATER REACTORS, A THERMAL NEAR BREEDER. Steinert, C. (Siemens A.G., Erlangen (West Germany)). May 1971. 15p. (CONF-710901-528). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Assuming that the task of advanced converters is to reduce the separative work required compared with light water reactors, to lower the cumulative uranium consumption and to permit wider utilization of fissile material resources without necessitating the development of a new reactor technology, the only solution offering minimum development cost would appear to be that using a D_2O pressurized water reactor of the pressure vessel type with a thorium fuel cycle. It would be possible to make full use of a field-proven reactor and fuel element technology for this advanced converter. Already with near breeders a considerable extension of nuclear resources and a remarkable reduction of separative work requirements can be achieved. Design parameters and fuel cycle cost estimates are presented for a pressurized heavy water reactor with a thorium fuel cycle. (10 references) (auth)

30212 (ANL-7775, pp 87-102) REACTOR AND ANALYTICAL CHEMISTRY. Crouthamel, C. E. (Argonne National Lab., Ill.). Apr 1971.

In Chemical Engineering Division annual report, 1970.

Progress is reported on studies of the chemical behavior of fast-reactor fuels with principal efforts being directed toward electron microprobe analysis of irradiated plutonium–uranium oxide fuels; studies of fuel-cladding interactions, fission product distribution and oxygen gradients in irradiated mixed oxide fuels; measurements of nuclear cross sections and fission yields for material of interest to the FBR program; and measurement of fast yields and the evaluation of changes in fission yields with neutron energy. (D.H.M.)

30213 (EURFNR-956) PRESSURE LOSS MEASUREMENTS ON A ROUGH BUNDLE OF RODS. Maubach, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of report KFK-1433. 32p. Dep. NTIS.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

A method of interpreting pressure drop measurements for bundles of rods with artificially roughened surfaces is described. Pressure drop measurements have been performed with a bundle of 19 roughened rods contained in a smooth hexagonal channel with flow of helium and air, respectively. The universal parameters, which have been derived from these measurements, have been compared with pressure drop measurements on rough surfaces in tubes and annuli. It is possible to calculate the pressure drop and the flow distribution in artificially roughened rod bundles by the method presented, if the shape of the artificial roughness is assumed. (12 references) (auth)

30214 (KFK-1400) FUEL ROD MODEL THEORY. MODEL AND MATERIAL DATA. Kaempf, H.; Elbel, H.; Kummerer, K. (comps.) (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Oct 1971. 353p. (In German). (EUR-4577). Dep. NTIS (U. S. Sales Only).

Thirty-two single contributions of different authors are presented. The discussion of the objectives of fuel pin modeling is followed by the presentation of a large number of existing computer codes in detail. Materials data of fuel and cladding are included. (auth)

30215 (KFK-1427) PRESSURE DROP FOR AN ISOTHERMAL, INCOMPRESSIBLE TURBULENT FLOW IN ROD BUNDLES WITH HEXAGONAL ARRANGEMENT OF THE RODS. Rehme, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Dec 1971. 41p. (In German). Dep. NTIS (U. S. Sales Only).

Systematic investigations were carried out on the pressure drop for an incompressible, isothermal, fully developed turbulent flow in rod bundles with hexagonal arrangement of rods. The results of measurements of the pressure drop over a range of Reynolds numbers $Re = 6 \times 10^2$ to 2×10^5 in 25 test sections are presented. The rods with rod distance ratios of $P/D = 1.025$ to 2.324 were surrounded by hexagonal channels. The number of rods was 7, 19, 37 and 61 respectively. On the basis of a critical survey of data from the literature and of the new measured results it was possible to give a generally valid statement about the pressure drop in rod bundles which is in contrast to other experimental and theoretical results. The pressure drop coefficient quickly rises from approximately 60% of the circular tube value for closely packed rods ($P/D = 1.0$) to the value for circular tubes for $P/D \approx 1.08$. For even higher rod distance ratios, the pressure drop coefficients rise but a little to about 10% above the values for circular tubes at $P/D = 2.0$. The number of rods in the rod bundle has no measurable effect on the pressure drop coefficient. (59 references) (auth)

30216 (KFK-1449) BURNUP DETERMINATION OF FUEL ELEMENTS FROM FAST REACTORS. Krause, Walter J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Jul 1971. 150p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Karlsruhe Univ. (West Germany).

Various methods of determining the burnup of thermal reactor fuel are discussed under the aspect of their applicability to fuel samples from fast reactors. The investigations relate to fuels with burnups between 0.25 and 1.5 atom percent. The concentration in the fuel of the fission product nuclides ^{143}Nd, ^{145}Nd, ^{146}Nd, ^{148}Nd, ^{150}Nd, ^{155}Eu and ^{144}Ce is linear proportional to the burnup values calculated through ^{148}Nd. Hence, these nuclides are good burnup monitors, whereas ^{144}Ce and ^{155}Eu can be applied as well in the destructive burnup determination as in the non-destructive gamma-scanning. In the burnup determination according to this method, the advantages of ^{155}Eu compared to other radioactive burnup monitors used on one hand consist in showing a very small tendency to diffuse in fuel and also to have a relatively long half-life; on the other hand, for a given fuel pin a destructive ^{148}Nd burnup analysis as a calibration is required. Deviations for ^{144}Ce occur due to the relatively short half-life of this nuclide, limiting its application only to fuels with short and simple irradiation histories. The average precisions of burnup determination methods and the average deviations for burnup values relative to ^{148}Nd are given. In stoichiometric fuels the fission products cerium and, to a smaller degree, europium have the tendency to form precipitates with barium in the hotter zones. A diffusion of neodymium isotopes in the fuel has not been observed within the limits of measuring accuracy. (122 references) (auth)

30217 (ORNL-TM-3726) BUNDLE ENTRANCE COOLANT VELOCITY PROFILES FOR THE FFM AND THE FFM WATER MOCKUP. Gambill, W. R. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 24p. Dep. NTIS.

The inlet configuration of the Fuel Failure Mockup (FFM) was geometrically and dynamically simulated in a subloop in the FFM Water Mockup to determine the uniformity of the radial velocity profile at the plane corresponding to the FFM rod-bundle entrance. Results derived from Pitot-tube traverses showed that the velocity distribution was quite flat ($V_{max}/V_{min} \approx 1.06$) and that profile modification devices such as turning-vane inserts were not needed in the tee located 20 in. below the bundle entry plane. Similar Pitot-tube traverses conducted at three flow rates in the triple-scale FFM Water Mockup demonstrated that the perforated plate located in the upstream tee sufficiently flattened the velocity profile ($V_{max}/V_{min} \approx 1.10$) following the 90-deg turn of the water into the tee. (auth)

30218 TEMPERATURE-ACTIVATED REACTOR CORE CLAMP. Stankiewicz, Raymond S. (to United States Atomic Energy Commission). U. S. Patent 3,629,070. 21 Dec 1971. Filed 9 Jun 1969.

A nuclear reactor core locking device is described which holds the fuel assembly loosely for refueling and less loosely against vibration under operating conditions. A U-shaped core retainer band surrounds and is spaced from the core. Contacting boxes are mounted in the channel attached by one or more bimetallic springs to the band. As heating up occurs the boxes are forced into contact with the core and the contact force increases with increasing temperature. (Official Gazette)

30219 BEHAVIOUR OF DEFECTIVE REACTOR FUEL. Locke, D. H. (United Kingdom Atomic Energy Authority, Preston, Eng.). pp 321-61 of Advanced Course on the Limiting Aspects of Fuel Element Performance in Water Cooled Power Reactors. Kjeller, Norway; Institutt for Atomenergi (1971).

Fuel defects arising can be observed and coped with in water reactors. Their incidence and deterioration can be analyzed from the coolant activity and remedial measures taken accordingly. Power can be reduced to meet the site design limits of activity release or containment activity. Power cycling should be avoided. Deterioration of the fuel will depend on the power of the pin (heat flux) and its materials of construction. The time interval an operator has between defect occurrence and gross failure of Zircaloy clad UO_2 pins to remove these is illustrated. All the remarks are related to "single" pins. No multiplication of failures has been observed in reactors over the years even with severe overheating and cladding loss. (auth)

30220 FUEL ELEMENT FOR A NUCLEAR REACTOR. Hepps, Michael B. L.; Ferrari, Harry M. (to Westinghouse Electric Corp.). U. S. Patent 3,647,623. 7 Mar 1972. Filed 26 Feb 1969.

A metallic clad fuel element for nuclear reactors is described which has a bellows-like member internally supported therein and communicably coupled with the environment of the fuel element so as to maintain an internal pressure substantially equal to the external or environmental pressure during burnup and load follow. The bellows-like member is preferably constructed of a material with a relatively high modulus of elasticity so that it may readily expand and contract to compensate for the amount of fission gas given off by the fuel during burnup. (auth)

30221 FUEL ELEMENT FOR A NUCLEAR REACTOR. Andrews, Harry N.; Patterson, John F.; Wilson, John F. (to Westinghouse Electric Corp.). U. S. Patent 3,647,622. 7 Mar 1972. Filed 13 Aug 1968.

A metallic clad sealed fuel element for a nuclear reactor is described which may be initially pressurized to resist creep collapse in the early stages of burnup and which has one or more normally sealed plenum chambers which are automatically punctured when predetermined increased pressures are reached during burnup to provide void space for fission gases. In one example, the plenum chambers each comprise an elongated bellows-like structure which when compressed by the increasing pressures within the fuel element cause a wall to be punctured by an internally mounted pin. (auth)

30222 VIBRATIONS OF THE FUEL PINS AND ASSEMBLIES OF THE PHENIX REACTOR. Ginier, R.; Pontier, M. (CEN de Cadarache, Saint-Paul-les-Durance, France). Houille Blanche; 26: No. 6, 513-17(1971). (In French).

From Meeting on some problems of hydro- and aeroelasticity; Paris, France (18 Mar 1971).

The vibrations of fuel elements immersed in Na flowing quasi-parallel to the fuel assemblies were studied as part of a program on the hydraulics associated with reactor technology. The studies were undertaken in view of ensuring that for the different element supporting arrangements and spacings, fatigue stresses affecting the safety of the reactor will not occur. Full size models of the assembly with simulated Na flow and very similar hydraulic and mechanical considerations were used. It was verified that under normal working conditions no dangerous vibrations for the fuel elements or assembly could occur. (France)

30223 BEHAVIOR OF FUEL ROD CLADDING USED IN LIGHT-WATER REACTORS. Tokyo; Nuclear Safety Research Association (1970). 118p. (In Japanese).

The results of studies on the behavior of fuel cladding rods in cores of light-water reactors at normal operation and accidents are presented: mechanical properties, anti-internal pressure resistance in particular, of Zircaloy cladding material; the behavior of fuel cladding rods at the time of a loss-of-coolant; fuel cladding rods and their integrity; the behavior of hydrides in cladding materials and the effects; and the reactions between zirconium and coolant water. (Japan)

30224 FAST BREEDER FUEL. Murray, P. (Westinghouse Electric Corp., Madison, Pa.). Reactor Technol.; 15: No. 1, 16-58(Spring 1972).

Fuel-pin irradiations in test reactors have demonstrated the high-performance capabilities of the mixed oxide-stainless steel system. Fission-gas release and fuel swelling can be accommodated, and the benefits arising from radiation-induced effects of swelling and creep in stainless-steel cladding give confidence that high-burnup targets for liquid-metal-cooled fast breeder reactor (LMFBR) fuel can be achieved. Fuel-cladding reaction has emerged as a potential problem that may limit peak cladding temperatures to which mixed-oxide fuel pins are designed and operated. Further detailed results on these limits are needed, particularly in the high-burnup (100,000 MWd/metric ton) range. Reactions caused by fuel-sodium interactions under dynamic coolant conditions do not appear to cause major operating problems. Definition of fuel-pin thermal-performance models requires additional experimental data to minimize the uncertainties. Stainless-steel swelling and irradiation-induced creep have, in effect, focused attention on the fuel assembly and behavior of the fuel-pin spacer system and the flow-duct system. These are vital areas in which more precise materials-irradiation data and interpretation for design are necessary. Present uncertainties can be overcome by design, given more reliable irradiation data to the high fluences required for LMFBR application. Accommodation of swelling does, however, introduce an economic penalty that highlights the importance of longer-term metallurgical solutions to the swelling problem. (114 references) (auth)

30225 SIMPLE METHOD OF CALCULATING THE RADIAL TEMPERATURE DISTRIBUTION IN A MIXED-OXIDE FUEL ELEMENT. Meyer, R. O.; Buescher, B. J. (Argonne National Lab., Ill.). Nucl. Technol.; 14: No. 2, 153-6(May 1972).

Approximate solutions in analytic form are presented for the heat-flow equation that yields temperature as a function of radial position in mixed-oxide fuel irradiated in a fast neutron flux. These equations are applied to fuel with density that varies due to restructuring. In addition, the necessary thermal conductivity data are discussed. Results, which do not require the use of a computer, are compared with a computer-generated numerical solution, and the agreement is shown to be within a few percent. (14 references) (auth)

Auxiliary Systems and Engineered Safeguards

Refer also to abstract 28159.

30226 TRANSFER MACHINE FOR NUCLEAR REACTOR. Muenchow, Herbert O. (to United States Atomic Energy Commission). U. S. Patent 3,629,062. 21 Dec 1971. Filed 12 May 1969.

A fuel transfer machine for a liquid metal cooled nuclear reactor is described in which a retractable guide tube and telescoping lifting arm are utilized to reach down into the reactor to lift out a transfer pot containing a fuel assembly immersed in liquid metal. The machine has an independent cooling system consisting of outer fins and a closed coolant system with an immersed heat exchanger. This cooling system is intended to remove heat generated by radioactive decay in the fuel assembly during its time in the transfer machine. (Official Gazette)

30227 PERIODIC TESTING OF PROTECTION SYSTEM ACTUATION FUNCTIONS. Safety Guide 22-1972. Washington, D. C.; Atomic Energy Commission (1972). 7p.

Acceptable methods of including the actuation devices in the periodic tests of the protection system during reactor operation are described. The frequency of such testing is not specified. (auth)

30228 EARTHQUAKE INSTRUMENTATION CRITERIA FOR NUCLEAR POWER PLANTS. ANS 2.2-1971. Hinsdale, Ill.; American Nuclear Society (1972). 10p.

The minimum requirements for earthquake instrumentation to provide information on the input vibratory ground motion and resultant vibratory responses of representative seismic Class I structures and equipment are presented. Should an earthquake occur the instrumentation output provides information to determine whether or not the plant can continue to operate safely. (auth)

Operation and Economics

30229 (AED-CONF-71-100-4) LOAD FOLLOWING BEHAVIOUR AND CYCLE DURATION FLEXIBILITY OF LIGHT WATER REACTOR POWER STATIONS. Boehm, W. (Siemens A. G., Erlangen (West Germany)); Janssen, U.; Kollmar, W.; Maerkl, H.; Voigt, O. May 1971. 19p. (CONF-710901-516). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Operating parameters and fuel cycle characteristics for pressurized-water and boiling-water power reactors under load following conditions are analyzed. (D.C.C.)

30230 USE OF COMPUTERS IN NUCLEAR FUEL MANAGEMENT. Brandfon, W. W. (Sargent and Lundy, Engineers, Chicago). IEEE (Inst. Elec. Electron. Eng.), Trans. Power App. Syst.; PAS-90: No. 6, 2534-9(Nov-Dec 1971).

The nuclear fuel cycle and some of the problems of fuel management are described. A description is given of various physics and economics computer codes used to assist in extracting the maximum benefits from this new energy source. (auth)

30231 EVALUATION OF THE LONG-TERM ROLE OF NUCLEAR POWER IN THE FUEL AND POWER BALANCE OF THE U.S.S.R. Makarov, A. A.; Makarova, A. S.; Vigdorchik, A. G.; (and others). At. Energ. (USSR); 32: No. 3, 187-96(Mar 1972). (In Russian).

An investigation of the long-term role of nuclear power in the fuel and power balance of the U.S.S.R. is presented. The analysis evaluates the effect of the rate of growth of nuclear power on the economy and structure of the long-term fuel and power balance as well as the effect of the basic economic and energy factors (oil and gas resources, power demand, costs of energy units, load factors) on power, location and optimal use of nuclear plants. (auth)

30232 SCALE OF ATOMIC POWER PLANT. Suganami, Saburo (Mitsubishi Atomic Power Industries, Inc., Tokyo). Opereshionzu Risachi; 15: No. 6, 18-22(Jun 1970). (In Japanese).

The scale problem to be considered in drawing up a new project for constructing an atomic power plant is described in terms of the load duration curve (LDC). When a LDC estimated for the future is given, the construction of the newest plant is not always the best way to supply the energy required; though the running cost may become cheap, the cost of construction will amount to a colossal sum. Rather, there exists the circumstance that it is more economical that the base load is covered by the newest plant and the peak load by an increase of old style plants (e.g., heat power plants). Therefore, a optimization problem arises. The problem is formulated for several kinds of power plants using a simple LDC. In case of two power plants, the problem is reduced to a simple minimization one. In case of three or more plants, functional equations are constructed on the basis of the principle of optimum and minimized with respect to the demand covered by the newest plant. A simple numerical example is given. However, the formulation must be modified since the introduction of new reactor is usually made without taking into account economy. An indication about how to modify the formulation is given. (Japan)

30233 OPTIMAL OPERATIONAL STRATEGY IN NUCLEAR FUEL MANAGEMENT. Civita, P.; Fornaciari, P.; Mazzanti, T. (Ente Nazionale per l'Energia Elettrica, Rome). Nucl. Technol.; 14: No. 2, 116-22(May 1972).

Digital computer methods are suggested to solve typical utility problems associated with nuclear fuel management, such as: (a) design or long-term planning (fuel enrichment, batch size selection, fuel reinsertions, planned exposure stretch-out); and (b) operation or short-term planning (unplanned stretch-out, advanced/postponed refueling or power reductions during the cycle to overcome high peak load periods). The goal is to minimize the total kWh cost, taking into account the fuel assembly purchase price, the resale value of the recovered products, the replacement energy cost, interest charges and savings arising from exposure stretch-out. Dynamic programming based on the Bellman principle was applied to achieve optimization. The economic prospects appear quite promising: a saving of up to 500,000 $/year may be achieved for a 800 MW(e) nuclear power plant. (auth)

30234 PRESSURIZED WATER REACTOR OPTIMAL FUEL MANAGEMENT. Naft, Barry N.; Sesonske, Alexander (Purdue Univ., Lafayette, Ind.). Nucl. Technol.; 14: No. 2, 123-32(May 1972).

As an initial step toward a comprehensive fuel management procedure, a model was developed to optimize fuel loading patterns in PWR's with regard to a specified function of burnup and power. For this purpose, the JUMBO code employs a simplified semianalytic function to represent X-Y power distribution, and a direct search scheme to optimize shuffling. The number of feasible patterns is greatly reduced through the use of a logical set of shuffling rules. The applicability of the method has been demonstrated for a typical 500 MW(e) PWR, considering both an initial and reload core. 20 references. (auth)

Safety and Siting

Refer also to abstracts 28050, 28051, 28056, 28057, 28072, and 30289.

30235 (AED-CONF-71-100-41) THERMAL POLLUTION CAPACITY OF SURFACE WATERS BY DISCHARGE OF COOLING WATER FROM NUCLEAR REACTORS. Liebmann, H.; Ruf, M. (Munich Univ. (West Germany). Bayerische Biologische Versuchsanstalt, Munich (West Germany)). May 1971. 20p. (CONF-710901-532). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The effects of power reactor thermal discharges on the aquatic life in surface waters are analyzed. The thermal limits for surface water systems are described. (D.C.C.)

30236 (FRNC-TH-104) AEROSOL STUDY USING ELECTRON DIFFRACTION. Ponchin, Georges-C. (Aix-Marseilles Univ. (France)). 1971. 71p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Aerosols were studied using electron diffraction. A method of reconstructing the reciprocal lattice of the particle was developed. The method was used for aerosols collected in the following circumstances: meltdown of Al canned U rods; radiological consequences of critical accidents (CRAC); powdered Na fires (FANAL). The method used allowed the concentration, grain size, and aerosol composition to be determined as a function of the temperature, flow rate, and certain other characteristics of the vector gas; it also enabled the fixation of fission products on these aerosols and the diffusion and settling of these aerosols on the walls, to be studied. (France)

30237 (KFK-1490) THEORETICAL TREATMENT OF THE AEROSOL BEHAVIOR IN A CLOSED CYLINDRICAL CONTAINER (PARDISEKO 1). Keller, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Nov 1971. 21p. (In German). Dep. NTIS (U. S. Sales Only).

After an accident in a reactor it is possible that radioactive aerosols may reach the containment. The behavior of these aerosols is governed by the following processes: sedimentation, diffusion and coagulation. These physical processes are mathematically treated, and a digital computer program is developed (PARDISEKO 1). In the numerical calculation it was assumed that the initial-concentration in the cylindrical containment is constant. The particle-concentration as a function of time was calculated and compared with the results found by experimental measurements. (7 references) (auth)

30238 (NP-19244) TRIKON: AN ALGOL PROGRAM FOR CALCULATING TRITIUM GENERATION AND DISTRIBUTION IN A PRESSURIZED WATER POWER REACTOR PLANT. Reactor Laboratory, Report 3. Mattila, Lasse J. (State Inst. for Technical Research, Otaniemi (Finland)). Dec 1971. 70p. Dep. NTIS (U. S. Sales Only).

An UNIVAC 1108 NU-ALGOL program, TRIKON, is described. The program computes tritium concentrations in process waters and the containment air of a pressurized water power reactor plant. The tritium sources taken into account are ternary fission in the fuel and the reactions of neutrons with the boron dissolved in the coolant. The program is specially designed for studying the effects of variation in essential reactor plant parameters on the tritium activity levels in various parts of the plant and on the amount of tritium activity released from the plant. The program may, to some extent, also be applied to other radionuclides produced in pressurized water reactors. (auth)

30239 (ORNL-tr-2585) [STUDY OF PROCESSES DURING BLOWDOWN OF WATER-COOLED REACTORS]. LARGE-SCALE VESSEL TEST STAND TO SIMULATE WATER-COOLED REACTOR BLOWDOWN. Zimmermann, M.; Stein, K. ([Battelle Institut e. V., Frankfurt am Main (West Germany)]). Translated for Oak Ridge National Lab., Tenn., from Report 6. 36p. Dep. NTIS.

Modifications to a steel vessel and test stand used to simulate the blowdown phase of water cooled reactor loss-of-coolant accidents are described. A 3.8 m section of the vessel was replaced by a new section of 8.5 m, so that the complete vessel height is 11.2 m. The design planning and modification procedures are presented. (H.D.R.)

30240 (ORNL-tr-2586) STUDY OF PROCESSES DURING BLOWDOWN OF WATER-COOLED REACTORS. INSTRUMENTATION TECHNOLOGY. Koehn, J.; Saeuberlich, C.; Skoutajan, R. (Battelle Institut e. V., Frankfurt am Main (West Germany)). Translated for Oak Ridge National Lab., Tenn., from Report 7. 95p. Dep. NTIS.

To investigate the phenomena in the depressurization of water-cooled reactors, equipment for measuring pressures, temperatures, forces, as well as mass flow and movements of the water level was constructed for experiments with a scale-model-pressure vessel of 11 m in height. Both the measuring equipment and the measuring and calibration methods are described. The amplifiers and recording instruments used are briefly discussed. The pressure history at an initial temperature of 280 to 290°C and rapid temperature variation during the experiment cannot be measured with sufficient accuracy (error <2 percent) even by means of high-temperature pressure transducers. Pressure transducers installed at regular intervals, however, produced satisfactory results. The thermocouples of 30-μm in diameter were developed further; their response time was reduced to about 0.5 ms. To improve the measuring accuracy a zero suppression unit was constructed, which permits temperatures in the range between 250 and 300°C to be measured with an accuracy of ±1 degree. The equipment for measuring the decrease in the weight of the vessel as a function of time was examined and improved. By means of a new type of mounting (span rope) of the vessel the measuring accuracy was improved to about ±2 percent (related to the real value). In the determination of the mass flow from the weight history of the vessel the error amounts to about ±3 percent. The natural oscillation of the systems measuring force and differential pressure was investigated. (auth)

30241 (ORNL-tr-2587) STUDY OF PROCESSES DURING BLOWDOWN OF WATER-COOLED REACTORS. TESTS WITH THE LARGE 11.2 m VESSEL WITHOUT INSIDE EQUIPMENT. Kanzleiter, T.; Koehn, J.; Saeuberlich, C.; Stein, K.; Zimmermann, M. (Battelle Institut e. V., Frankfurt am Main (West Germany)). Translated for Oak Ridge National Lab., Tenn., from Report 8, Volume I. 91p. Dep. NTIS.

The blowdown of BWR and of pressurized water reactors (PWR) from 70 and 130 atm was simulated following rupture of the primary cooling circuit directly at the vessel fitting of a steel vessel of 11.2 m height. With the use of 30 μm bare-wire thermocouples, which have a very rapid response, it was possible to demonstrate that water without nucleation appears for a short time in the vessel in all cases during the first $^1/_{10}$ sec of blowdown. By expanding the pressurized water or the steam present under BWR conditions, the vessel pressure drops very rapidly in this phase. A comparison of the measured pressure drop by approximate calculations shows that in the PWR tests the outflowing medium behaves approximately like water in this initial phase. In contrast, in the BWR-tests a critical outflow of a two-phase mixture or steam occurs immediately. Approximately 0.1 sec after the start of the test, the first steam bubbles form in the container, the boiling equilibrium is reattained by temperature decrease and a pressure increase. If the water level is above the nipple, a two-phase mixture with a small steam component is discharged with a relatively low critical volumetric flow rate, the water level drops, and rising steam bubbles increase the steam plenum in the top of the container. If the water level is below the nipple, steam is discharged at a high critical volumetric flow rate, the violent steam generation which begins in the vessel drives the water level up to the nipple, and the critical volumetric flow rate decreases again. In both cases the water level oscillates at the height of the outlet nipple for a fairly long time. Only in the final phase of the blowdown process have the vessel contents and pressure decreased to such a degree that the water level can no longer reach the vessel nipple. (12 references) (auth)

30242 (ORNL-tr-2588) STUDY OF PROCESSES DURING BLOWDOWN OF WATER-COOLED REACTORS. TESTS WITH THE LARGE 11.2 m VESSEL WITHOUT INSIDE EQUIPMENT. Christ, W.; Kanzleiter, T.; Koehn, J.; Saeuberlich, C.; Stein, K.; Zimmermann, M. (Battelle Institut e. V., Frankfurt am Main (West Germany)). Translated for Oak Ridge National Lab., Tenn., from Report 8, Volume II. 173p. Dep. NTIS.

Blowdown tests in a steel vessel of 11.2 m height without inside installations under boiling water (BWR) and pressurized water (PWR) conditions are described. The test results are recorded in diagrams. They are classified according to tests and are presented in the following sequence: (1) Test conditions and location of instrumentation sites. (2) Vessel pressure at several sites and static pressures in the zone of the blowdown nipple. (3) Temperatures of the vessel contents at several sites. (4) Horizontal momentum of the outflowing medium. (5) Weight of the vessel contents. (6) Pressure difference between the upper (nipple H) and lower end of the vessel. (7) Pressure difference between the lower vessel end and nipple E located somewhat above the middle of the vessel. (8) Mass flux of the outflowing medium. (9) Temperature-pressure diagram. The results of all successful BWR tests and PWR tests as well as two cold-water tests are presented. (auth)

30243 METHOD OF THE BETHE–TAIT TYPE FOR THE ANALYSIS OF HYPOTHETICAL DESTRUCTIVE ACCIDENTS IN FAST REACTORS. Adamik, Vladislav (Power Research Inst., Jaslovske Bohunice, Czech.). Jad. Energ.; 17: No. 11, 370-3(Nov 1971). (In Czech).

The analytical method of the Bethe–Tait type for the analysis of destructive accidents in fast reactors is given. The described mathematical model for the determination of total energy release is essentially Nicholson's modification of the Bethe–Tait model and explosive energy release is determined on the basis of fuel isoentropic expansion. The described model has been embodied in the IBM 7040 Fortran IV program POWEX and results of applying this program to a 60 MW(t) fast reactor are presented. (auth)

30244 SAFETY STUDY ON POWER PLANT SYSTEMS IN JAPAN. SAFE AND ROSA PROJECTS. At. Jap.; 15: No. 7, 10-14(Jul 1971).

Safety studies pursued in Japan on light-water reactors, activities in the SAFE (Safety Assessment and Facilities Establishment) committee, and the ROSA (Research on Safety Assessment—Loss of Coolant) program are described. Purpose of the SAFE project, as a part of JAIF, is to study the effectiveness of safety devices against MCA in LWRs. The ROSA program in JAERI is made up of ROSA-I and -II. The former is concerned with phenomena of accidents prior to operation of emergency core cooling systems. In the latter effects of the emergency cooling system will be studied. The ROSA facilities include a mock-up pressure vessel, water circulation and injection systems, etc. (Japan)

30245 SAFETY EXPERIMENTATION OF ADVANCED THERMAL REACTOR. Nakata, Seibei (Power reactor and Nuclear Fuel Development Corp., Oarai, Japan). Genshiryoku Kogyo; 17: No. 10, 35-40(Oct 1971). (In Japanese).

Objectives, test equipment, and procedures of a safety experiment for a prototype Advanced Thermal Reactor are described. The experiment uses full scale test equipment to improve accuracy and reduce unknown factors in getting data concerning (1) mechanical effect of a blowdown jet on neighboring tubes and calandria tank when a pressure tube in the reactor core ruptures, (2) characteristics and features of the blowdown when either a large bore downpipe, an inlet pipe for a pressure tube at the underside of the reactor core, or a main steam pipe ruptures, (3) performance of trial products or trial production models of non-return valves and main steam isolation valves under operating conditions. Test equipment is described. The experiments for pressure tube rupture, downpipe rupture and inlet pipe rupture were performed, and the experiment for main steam pipe rupture is being carried out. Initiating methods of the tube rupture, a picture of rupture, measurement of maximum impact pressure on neighboring tubes, and two records on blowdown and temperature

change of a fuel assembly are given for the pressure tube rupture test. Measurement results are given for the downpipe rupture. Comparison between results of experiment and analysis by code "SENHOR" was carried out. Records of one of the experiments for inlet pipe rupture and main steam pipe rupture are also given. Other experiments to follow are explained. They are experiments on emergency cooling, isolation valves, and non-return valves. (Japan)

30246 THEORETICAL STUDY OF TRANSIENT SODIUM BOILING IN REACTOR COOLANT CHANNELS UTILIZING A COMPRESSIBLE FLOW MODEL. Siegmann, Eric Raymond. Evanston, Ill.; Northwestern Univ. (1971). 178p. University Microfilms Order No. 72-7840.

Thesis.

The behavior of sodium during boiling and expulsion is an important consideration in the safety of a liquid metal cooled fast-breeder reactor. A single coolant channel is analyzed to obtain a detailed description of the sodium coolant density (vapor void fraction) in space and time during flow or power transients that lead to coolant boiling. Such information is necessary to accurately calculate feedback-reactivity effects in large, fast-breeder reactors. The model described solves the three, complete, coupled conservation equations simultaneously for the two-phase region. The equations for the two-phase region are solved simultaneously with equations for the single-phase region of the coolant and for heat transfer of the fuel element. The model predicts the time-dependent voiding of the sodium coolant starting from steady-state conditions with subcooled liquid. The model was developed to analyze power-transient and loss-of-flow accidents. Power transients were simulated by exponentially increasing the fuel power density. Loss-of-flow accidents were simulated by exponentially decreasing the pressure in the lower plenum. Transients in an oxide-fueled, fast-breeder-reactor coolant channel were analyzed using a Fortran computer program, and the results show that after boiling starts: (1) the boiling propagates upstream quickly, although pressure effects on the saturation temperature tend to suppress the growth of the two-phase region; (2) the mass flow rate at the channel entrance decreases very rapidly; (3) pressures encountered in all problems were not excessively high. The results of this model were compared with the results of a simpler momentum-integral model. The comparison showed that the momentum-integral model overestimates the voiding rate at the start of the transient, but underestimates it later. In general however, the agreement between the two models was good for the cases compared. (Diss. Abstr. Int., B)

30247 ANOMALOUS OSCILLATIONS IN STEAM–WATER SYSTEMS UNDERGOING DEPRESSURIZATION. Steves, Lewis Hardeman. Seattle; Univ. of Washington (1971). 203p. University Microfilms Order No. 72-7422.

Thesis.

The previously-observed oscillatory behavior of the steam-water mixture in the vessel during nuclear reactor loss-of-coolant tests is investigated. Anomalous vertical oscillations, or chugging, had been observed in small-scale, low-pressure experiments in glass vessels. Such behavior has definitely been absent in small-scale, high-pressure experiments; however, pronounced audible oscillations had been recorded in large-scale, high-pressure experiments. All these experiments are analyzed with regard to the oscillatory behavior. A theoretical model is proposed which uses an approximate separation of variables technique to allow the inclusion of momentum effects within the vessel without the problems associated with the usual hyperbolic partial differential equation formulation. The resulting model is thus able to predict vertical oscillations. Bubble growth controlled by heat transfer and bubble slip corrected for the effect of the accelerating fluid are also included in the model. This model is implemented in its entirety for numerical integration as a system of ten simultaneous ordinary differential equations with numerous auxiliary computations. The model is simplified for analog computer simulation and further reduced to a closed solution for the characteristic chugging frequency. The model shows excellent agreement with the glass-vessel experiments with regard to the occurrence and relative amplitude of the chugging oscillations. The theoretical frequency is four times the actual experimental frequency; however, this ratio is remarkably constant for the available data. Simulation of the high-pressure experiments indicates that chugging is not the cause of the recorded oscillatory behavior. Application of a sloshing model for horizontal swaying motion to those experiments shows the frequencies for this mode of oscillation to agree quite closely with the actual frequencies. Further simulations with the chugging model show that vertical oscillations are only remotely possible at high pressures, and then only in extremely tall vessels with negligible internal resistances. It is concluded, therefore, that vertical oscillatory behavior during a loss-of-coolant accident need not be considered in the design of safety systems for water-cooled nuclear reactors. (Diss. Abstr. Int., B)

30248 ONSITE METEOROLOGICAL PROGRAMS. Safety Guide 23-1972. Washington, D. C.; Atomic Energy Commission (1972). 13p.

A suitable onsite meteorological program to provide meteorological data needed to estimate potential radiation doses to the public as a result of the routine or accidental release of radioactive materials to the atmosphere is presented. (auth)

30249 THERMAL DISCHARGES: A LEGAL PROBLEM. Thomas, William A. Tenn. Law Rev.; 38: No. 3, 369-90 (Spring 1971).

Legal aspects of thermal discharges into the environment are examined. Emphasis is placed on problems with heated water discharges from nuclear power plants, and judicial and legislative actions concerning power generating facilities are reviewed. (H.D.R.)

30250 ENGINEERING FOR RESOLUTION OF THE ENERGY-ENVIRONMENT DILEMMA. Washington, D. C.; National Academy of Engineering (1972). 353p. National Academy of Sciences, Washington, D. C.

The results of a study on power plant siting are presented. Procedures for mitigating power plant siting conflicts between environmentalists and electric power utilities are proposed. Research and development projects which might contribute to minimizing the conflicts within 20 years are identified. Information relevant to specific aspects of the energy-environment crisis is included. (H.D.R.)

30251 FIRST LOSS OF FLOW EXPERIMENT WITH AN FTR-TYPE FUEL PIN IN THE MARK-II LOOP. Carter, J. C. (Argonne National Lab., Ill.); Purviance, R. T.; Boland, J. F.; Dickerman, C. E.; Hanson, J. E. Nucl. Technol.; 14: No. 2, 133-45 (May 1972).

The Argonne Mark-II loop in the core of the TREAT reactor was used to investigate the thermodynamics of a sodium-cooled fast-reactor fuel pin. The experiment on the top 30.44 cm of an unirradiated FTR (Fast Test Reactor) fuel pin was the first in a series to be conducted in support of the LMFBR program and as such constituted an exploration into the ability of the loop and reactor facility to produce simulations of a wide-range of flow conditions in assemblies of sodium-cooled fast-reactor fuel pins. The objective of the first experiment was to approach, but not cross over, the threshold of the structural integrity of the cladding by reducing the sodium velocity while the pin was continuing to generate heat at the full power + 20% rate of an FTR pin. This objective was achieved, despite perturbations in sodium velocity and temperature of greater amplitude and frequency than anticipated and with some irreversible structural changes in the pin. (auth)

Steam and Power Conversion System

30252 GAS TURBINE INSTALLATION USING NUCLEAR ENERGY OR FOSSIL FUELS AS HEAT SOURCE. (to Siemens Aktiengesellschaft). British Patent 1,263,124. 9 Feb 1972. Priority date 24 Apr 1968, Germany.

POWER PLANTS—design of indirect cycle carbon dioxide gas turbine, with fossil or nuclear heat source

REACTORS, POWER—power conversion system for, design of indirect cycle gas turbine

TURBINES—design of indirect cycle gas, for gas cooled reactors (H.D.R.)

30253 INVESTIGATIONS ON AN AXIAL FLOW COMPRESSOR WITH LOW ENTRANCE HUB RATIO AND WITH HIGH LOAD PER STAGE IN NUCLEAR POWER PLANTS. Bammert, K.; Turanskyi, L. (Inst. of Turbomachinery and Gasdynamics, Hanover). Atomkernenergie; 19: No. 2, 85-91(Apr 1972).

A report is given on a three-stage axial flow compressor with the tip diameter of the blading held constant at 340 mm. It delivers a mass flow of 11 kg/s and reaches a pressure ratio of 2. The compressor was designed using a vortex distribution which corresponds to a modified solid body flow. With this flow distribution an enthalpy gradient was generated in the first stage rotor, and it is retained in the following stages. Experimental investigations of the flow in front of and behind the blading were carried out for various speeds and flow volumes in order to ascertain how the flow changes under different operational conditions. (auth)

30254 MODELING AND CONTROL OF GAS-COOLED NUCLEAR STEAM SUPPLY SYSTEMS. Netzel, L. J. (Gulf General Atomic Inc., San Diego, Calif.). Advan. Instrum.; 25: Pt. 1, 514.1-36(1970).

From twenty-fifth annual conference of the Instrument Society of America; Philadelphia, Pa. (26 Oct 1970).

A method for developing a simple mathematical model of a gas-cooled nuclear steam supply system is described. The application of this mathematical modeling approach is useful, in particular, to the design of plant control systems. The equations and the model techniques used for the plant model are presented. 19 references. (auth)

30255 IMPROVEMENTS RELATING TO STEAM SEALING IN STEAM TURBINE POWER PLANTS. (to General Electric Co.). British Patent 1,267,548. 22 Mar 1972. Priority date 31 Jul 1968, United States.

REACTORS, BOILING—turbines for, design of non-contaminated shaft seal system for
SEALS AND GLANDS—design of non-contaminated shaft, for steam turbines
TURBINES—shaft seal system for boiling water reactor, design of non-contaminated (H.D.R.)

Commercial Power Reactors

30256 (FIND-50289(4-72)) FIND: THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Revision 1. Smith, James G. (ed.) (Technical Information Center (AEC), Oak Ridge, Tenn.). 18 Apr 1972. 27p. Dep. NTIS.

An index to microfiche issuances of safety analysis reports is provided. Subject citations are to specific frames on the microfiche. (J.M.J.)

30257 (TID-3324) TITLE LISTING OF CIVILIAN POWER REACTOR DOCKET LITERATURE IN NUCLEAR SCIENCE ABSTRACTS. Volumes 21-25(1967-1971). (Technical Information Center (AEC), Oak Ridge, Tenn.). Mar 1972. 355p. Dep. NTIS.

A title list of all safety analysis report literature (DOCKETS) on reactors and fuel reprocessing plants, which had been processed for Nuclear Science Abstracts (NSA) through 1971, is presented. Arrangement of text is by DOCKET number. Two tables of contents are included, one listed by DOCKET number, the other is an alphabetical listing of the facilities. The NSA subject indexing for these entries is also reprinted. (J.M.J.)

30258 REACTIVITY MEASUREMENTS AT BELOYARSK POWER REACTORS. Dubovskii, B. G.; Evseev, A. Ya.; Kisil, I. M.; (and others). At. Energ. (USSR); 32: No. 3, 205-9(Mar 1972). (In Russian).

The measurement of instantaneous values of reactivity is described. The results of using the reactimeter for studying stationary and transient reactivities at startup and at power levels of reactor operation are presented. An analysis of certain methodological features of reactivity measurements is given. The applicability of the reactimeter as an integral part of the reactor monitoring system is discussed. (auth)

30259 700 MW COOPERATIVE NUCLEAR POWER PLANT TULLNERFELD. Bechhold, E. (Kernkraftwerk Union AG, Erlangen, Ger.); Koeth, D.; Huettl, A. Atomwirt., Atomtech.; 17: No. 3, 146-53(Mar 1972). (In German).

The design principles of the first Austrian nuclear power plant at Tullnerfeld are described. They are based on practical experiences originating from the comparable boiling water reactors Brunsbuettel and Philippsburg. In comparison with these installations, improvements are being planned: a mixed-preheater (water container with degassing facility) is included into the regenerative preheating system. Particularly advantageous for operation in Austria is the flexibility of the cycle end. In addition to favorable properties of power control, high maximal power can be obtained in the case of failure involving cooling water pumps. Designs for nuclear safety are so comprehensive as to guarantee zero leakage from the safety containment vessel, even in the case of the most severe, hypothetical, cooling medium accident. Construction of the reactor building is scheduled for February 1972. Operational testing is projected for July 1976. (tr-auth)

30260 DEMARCATION OF COVER BETWEEN TECHNICAL INSURANCES AND COMBINED MATERIAL LOSS AND DAMAGE INSURANCE FOR NUCLEAR PLANTS. Vandrey, H. J. (Allianz Versicherungs-AG, Munich). Allianz Ber. Betriebstech. Schadenverhuetung; No. 15, 30-3(1971). (In German).

In a steam power plant of the conventional type, the risks of fire and explosion on the one hand and machinery damage on the other are important factors. In a nuclear power plant, additional hazards must be taken into account which ensue from the peculiarities of nuclear energy, viz. the excessive heat generated during nuclear transmutation and the possibility of radioactive contamination. These additional risks are covered by an extended fire insurance offered in the form of a "Combined Insurance against Material Loss or Damage Ensuing from Nuclear Energy and Fire." While inclusion of the nuclear energy risk—in the case of fire insurance—thus results in an extension of the scope of cover, an increase in the risk of fire and explosion and an increase in the maximum possible loss, in the case of machinery insurance the presence of nuclear energy results merely in an increase in the latter. In the event of radioactive contamination occurring in the conventional section of the power plant as a result of machinery damage, the costs incurred in rectifying this are covered under the combined property loss and damage insurance. In the event of machinery damage within the biological shield, cover is afforded under the machinery insurance on a first loss basis for the conventional loss or damage and the additional costs. (INIS)

30261 670 MW NUCLEAR POWER PLANT WUERGASSEN. Ringeis, Wilhelm; Bindewald, Hilmar; Pilhofer, Karl-Heinz; Reiss, Erich; Rowotzki, Dieter (Kernkraftwerk, Wuergassen, Ger.). At. Strom; 17: No. 11-12, 173-92(Nov-Dec 1971). (In German).

On October 28, 1967, the Preussische Elektrizitats-AG Hannover let a contract to AEG Telefunken for construction of a nuclear power plant with a boiling water reactor of 670 MW gross electric power. After a four year construction time, the reactor became critical on October 22, 1971. In December 1971, the first phase of power experiments was started. Discussed are site, steam generating system, and main heat circuit. Technical data of the power station are presented. (H.B.G.)

30262 STATUS OF NUCLEAR POWER AT THE END OF 1971. Com. Naz. Energ. Nucl., Notiz.; 18: No. 2, 37-54 (Feb 1972). (In Italian).

Presented is a detailed analysis of the evolution of orders for nuclear power plants on hand in 1971, showing the trends that are emerging in the various countries, the different reactor types, and their builders. The data for 1971 are considered against the background of the general nuclear power program. Based chiefly on the elements that emerged in the course of the IV Geneva Conference, economic and financial development prospects are discussed with respect to both the industrialized countries and those that are still lacking nuclear power plants. 52 references. (auth)

Control and Instrumentation

30263 (FRNC-CONF-24) AFTER-HEAT REMOVAL, THERMOSIPHON, IN GAS REACTORS. Gutner, G.; Baby, J. P. (Electricite de France, Chatou, Departement Transferts Thermiques et Thermodynamique). Aug 1971. 30p. (In French). (CONF-710939-5). Dep. NTIS (U. S. Sales Only).

From Conference on natural and mixed convection and its industrial application; Ermenonville, France (13 Sep 1971).

The problem of cooling low load gas nuclear reactors (after-heat removal) involves minimizing the flow such that damage to the fuel element is avoided. The test installations used to study the EDF reactors are presented. The thermal tests are discussed: upward flow tests (Chinon 3) and downward flow tests (Saint-Laurent-des-Eaux and Bugey). The results obtained demonstrate the effect of natural convection on the thermal transfer when the gas circulation rate is low (less than 0.5 m/s). Cooling by thermosiphon was also studied and the conditions associated with flow reversal in downward circulation, and very small flow (forced convection), were examined for the test loop ESTHER. (France)

30264 (GULF-GA-A-10839) FORT ST. VRAIN UNIT 1 PCRV PRESSURE TEST REPORT FOR THE PUBLIC SERVICE COMPANY OF COLORADO. Ople, F. S. Jr.; Gotschall, H. L. (Gulf General Atomic Co., San Diego, Calif.). Dec 1971. Contract AT(04-3)-633. 58p. Dep. NTIS.

The pressure test of the prestressed concrete reactor vessel (PCRV) of the 330-MW(e) High Temperature Gas-Cooled Reactor for the Fort St. Vrain Nuclear Generating Station was conducted during the period July 29 to August 14, 1971. The test demonstrated that the PCRV is soundly constructed, and that it responds to pressure loading up to 970 psig in a manner consistent with

the structural design. The overall structural response of the PCRV during the pressure test is characterized as follows: (1) The structural response of the vessel to pressure changes up to 970 psig is essentially linear. (2) A condition of net compression was maintained at all cross sections in the vessel at 970 psig. (3) The vessel was structurally stable while maintaining the pressure of 970 psig for approximately 8 hours. Only minor, superficial concrete cracking was observed during the pressure test. (4) Comparison of measured and calculated data shows acceptable agreement indicating predictability of vessel structural behavior up to a pressure of 970 psig. (auth)

Operation and Economics

30265 (AED-CONF-71-100-5) OPERATING EXPERIENCE WITH THE THREE DEMONSTRATION POWER STATIONS OF GUNDREMMINGEN (KRB), OBRIGHEIM (KWO), AND LINGEN (KWL). Weckesser, A.; Schenk, H.; Deublein, G.; Keller, W.; Kornbichler, H. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany). Kernkraftwerk Obrigheim G.m.b.H. (West Germany). Kernkraftwerk Lingen G.m.b.H. (West Germany)). May 1971. 17p. (CONF-710901-517). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Operations and maintenance requirements are reviewed for the Gundremmingen Power Reactor, the Obrigheim Power Reactor, and the Lingen Power Reactor during 1968 to 1970. (D.C.C.)

30266 (DOCKET-50003-106) INDIAN POINT STATION, UNIT 1. Excess Radioactivity in Steam Generators. Consolidated Edison Co. of New York, Inc., New York). 21 Apr 1972. 3p. Dep. NTIS.

30267 (DOCKET-50003-107) INDIAN POINT STATION, UNIT 1. Control Rod 12 Failed to Insert Fully. (Consolidated Edison Co. of New York, Inc., New York). 21 Apr 1972. 4p. Dep. NTIS.

30268 (DOCKET-50010-106) DRESDEN NUCLEAR POWER STATION, UNIT 1. Reactor Head Vent Pipe Leak. (Commonwealth Edison Co., Chicago, Ill.). 21 Apr 1972. 4p. Dep. NTIS.

30269 (DOCKET-50016-155) ENRICO FERMI ATOMIC POWER PLANT. Report for December 1971. (Power Reactor Development Co., Detroit, Mich.). 13 Apr 1972. 12p. (PRDC-EF-100). Dep. NTIS.

30270 (DOCKET-50133-84) HUMBOLDT BAY POWER PLANT, UNIT 3. Two Malfunctions of Propane Engine-Driven Generator. (Pacific Gas and Electric Co., San Francisco, Calif.). 17 Apr 1972. 2p. Dep. NTIS.

30271 (DOCKET-50213-138) HADDAM NECK PLANT, UNIT 1. Operation Report 72-3, March 1972. (Connecticut Yankee Atomic Power Co., Haddam). 21 Apr 1972. 15p. (NYO-3144-70). Dep. NTIS.

30272 (DOCKET-50219-180) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Loss of Secondary Containment Integrity. (Jersey Central Power and Light Co., Morristown, N. J.). 20 Apr 1972. 2p. Dep. NTIS.

30273 (DOCKET-50220-88) NINE MILE POINT NUCLEAR STATION, UNIT 1. Authorized to Perform Concurrent Maintenance Work as Requested. (Division of Reactor Licensing (AEC), Washington, D. C.). 14 Apr 1972. 2p. Dep. NTIS.

30274 (DOCKET-50220-89) NINE MILE POINT NUCLEAR STATION, UNIT 1. Malfunction in a Continuous Power Supply. (Niagara Mohawk Power Corp., Lycoming, N. Y.). 18 Apr 1972. 5p. Dep. NTIS.

30275 (DOCKET-50220-90) NINE MILE POINT NUCLEAR STATION, UNIT 1. Turbine Trip and Reactor Scram on December 31, 1971 Result of Accidental Bump to Level Sensors. (Niagara Mohawk Power Corp., Lycoming, N. Y.). 19 Apr 1972. 4p. Dep. NTIS.

30276 (DOCKET-50237-228) DRESDEN NUCLEAR POWER STATION, UNIT 2. Paddle Missing on Peeco Flow Switch. (Commonwealth Edison Co., Chicago, Ill.). 14 Apr 1972. 3p. Dep. NTIS.

30277 (DOCKET-50244-96) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Plans to Repair Tube Sheet Cladding in Steam Generators. (Rochester Gas and Electric Corp., N. Y.). 14 Apr 1972. 6p. Dep. NTIS.

30278 (DOCKET-50254-72) QUAD-CITIES STATION, UNIT 1. Failure of Flow Switches Used to Monitor RHR Flow. (Commonwealth Edison Co., Chicago, Ill.). 23 Feb 1972. 2p. Dep. NTIS.

30279 (DOCKET-50254-80) QUAD-CITIES STATION, UNIT 1. Seismic Restraints and Pipe Hangers on Residual Heat Removal System Found to be Damaged. (Commonwealth Edison Co., Chicago, Ill.). 11 Apr 1972. 2p. Dep. NTIS.

30280 (DOCKET-50254-84) QUAD-CITIES STATION, UNIT 1. Reactor Core Isolation Cooling System Failed to Perform at a Reactor Pressure of 950 psig. (Commonwealth Edison Co., Chicago, Ill.). 19 Apr 1972. 2p. Dep. NTIS.

30281 (DOCKET-50265-66) QUAD-CITIES STATION, UNIT 2. Heat Tracing on Pump Section Piping on Standby Liquid Control System Inoperable. (Commonwealth Edison Co., Cordova, Ill.). 24 Apr 1972. 1p. Dep. NTIS.

30282 (DOCKET-50266-66) POINT BEACH NUCLEAR PLANT, UNIT 1. Power Operation Without Required Degree of Redundancy for Power Range Channel Trips. (Wisconsin Electric Power Co., Milwaukee). 24 Apr 1972. 3p. Dep. NTIS.

30283 (DOCKET-50271-78) VERMONT YANKEE NUCLEAR POWER STATION. Abnormal Occurrence AO-72-1, Standby Gas Treatment System May Not Have Performed as Specified. (Vermont Yankee Nuclear Power Corp., Rutland). 14 Apr 1972. 2p. Dep. NTIS.

30284 (EUR-4758) OBRIGHEIM NUCLEAR POWER PLANT. Annual Report, 1970. (Kernkraftwerk Obrigheim G.m.b.H., Stuttgart (West Germany)). 1972. 88p. (In German). Dep. NTIS (U. S. Sales Only). EUR BF 165,-.

Good operating results were again produced in 1970 by the Obrigheim nuclear power plant, which is used as a base-load station. The plant's gross continuous electrical rating was 345 MW, and the net output, measured behind the longitudinal and transverse regulating transformer, was 328 MW. About 2.53×10^9 kWh were produced and approximately 2.39×10^9 kWh supplied to the grid. An availability of 83.9% was achieved for the year, despite a seven-week shut-down, planned well in advance, for the first refuelling, inspection of the nuclear components and overhaul of the conventional components. The year saw 16 shut-downs—four schedules and 12 unscheduled. None of these shut-downs was due to an unsafe operating condition in the plant. At no time was the safety of the plant, its personnel or the surrounding area affected. During 1970 about 7,700 Ci were released to atmosphere via the stack in inert gases with the exhaust air, i.e., approximately 9.6% of the officially permitted value. A total of 3.24 Ci was discharged into the river with the waste water, corresponding to about 18% of the officially permitted value. (auth)

30285 EXPERIENCE WITH THE STEAM GENERATING SYSTEM OF THE NUCLEAR POWER PLANT LINGEN UP TO THE FIRST REPLACEMENT OF FUEL ELEMENTS. Deublein, O. (Kernkraftwerk Lingen GmbH, Darme, Ger.). Allianz Ber. Betriebstech. Schadenverhuetung; No. 15, 5-9(1971). (In German).

During the 21 months of operation from October 1968 to July 1970, 3.2 tWh were generated. Exploitation of the operating time capacity of the nuclear power plant was 83%, the availability 91%. Half of the non-availability consisted of programmed stoppages, which it was possible to schedule during periods of low grid loading. As the excess reactivity factor "0" was already reached before the planned replacement of fuel elements, the reactor had to be operated for a time with fully-extended control rods, which at a capacity loss of 0.34% a day was possible for a period of 2½ months. The damage to the fuel elements was reflected by a constant increase in the iodine and neptunium activity. As a result of leaks in the system—such as around the glands—the aerosol

activity increased at times to such an extent that difficulties arose in carrying out servicing and maintenance work. (INIS)

30286 DOSIMETRIC PARAMETERS IN THE OPERATION OF RHEINSBERG NUCLEAR POWER PLANT. Schreiter, W.; Schwenzke, G. (VEB Kernkraftwerk, Rheinsberg, Ger.). Kernenergie; 14: No. 10, 329-32(Oct 1971). (In German).

Radiation safety in the operational regime of Rheinsberg nuclear power plant is evaluated from the operator's view in the light of some selected dosimetric parameters for the period of the first three reactor campaigns. The preceding general considerations about radiation protection in this period serve for imparting technical-organizational experience and include references to problems to be taken into account in construction of further nuclear power plants already in design phases. (auth)

30287 STADE NUCLEAR POWER STATION AT THE STAGE OF TAKING INTO OPERATION. Chudzienski, Ernst; Krille, Alfred; Ruebenberg, Patrick (Kernkraftwerk GmbH, Stade, Ger.). At, Strom; 17: No. 11-12, 192-8(Nov-Dec 1971). (In German).

The present state of taking into operation in the nuclear power station area and in the electrical installations in the Stade nuclear power station (KKS) is described. Further the additional screening arrangements in the hygiene control range, the control of fuel element preparation, environment supervision and the training of personnel are discussed. (auth)

30288 200 MWt OPERATING EXPERIENCE OF ENRICO FERMI FAST BREEDER REACTOR. Ikemoto, Ichiro; Yoshiki, Nobuya; Takeshita, Toshihide Nippon Genshiryoku Gakkaishi; 14: No. 3, 113-23(Mar 1972). (In Japanese).

The Enrico Fermi fast breeder reactor, reloaded with fresh fuel, again achieved criticality on July 18, 1970, following four years of repairs and modifications to remedy the limited fuel meltdown accident in October 1966. On October 16, 1970, the plant first attained its full licensed power level of 200MW(t). The subsequent low-power and high-power nuclear test program was completed with a 5 day power demonstration run at the full licensed power level during the week of November 15, 1970. Some 90 preloading, nuclear and plant monitoring tests covering all components and systems of the plant were prepared, conducted and evaluated. They include the performance tests of flow guards, (which were newly added to subassemblies to prevent any significant reduction of coolant flow by flat plate), of the malfunction detection analyzer (MDA), and of the delayed neutron detectors. The results of these tests were highly satisfactory. Stable operation of the modified steam generator, the effectiveness of the MDA for early warning of anomalous occurrences, and other results obtained should provide experience and data of great significance to the development, design, licensing and operation of future fast breeder reactor plants. The operating experience of the Fermi reactor up to 200MW(t) is summarized. (14 references) (auth)

Safety and Siting

30289 (CONF-701065-1) COST ANALYSIS OF MULTIPLE POWER REACTOR SITING AT HANFORD. Young, J. R.; Burnham, J. B.; Batch, J. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov 1970. 27p. Dep. NTIS.

From Meeting of the Tri-City Nuclear Industrial Council; Richland, Wash. (28 Oct 1970).

Significant capital cost savings can be made in the construction of nuclear power plants if two reactors are built at a common site. Since considerable interest is being shown in locating commercial power plants at Hanford, the savings which might be made by building two reactors on a single Hanford site, are studied. The most significant conclusions from this study are: capital cost savings of $32 million can be realized by building a DUPLEX—two nuclear power plants constructed in a fully coordinated sequence and sharing a common control room, turbine gallery, service area, river pump house and cooling pond; and savings of $15 million are possible on ADJACENT construction of the two plants where construction is fully coordinated but only a river pump house and cooling pond are shared. The savings indicated in either of these two cases will be reduced significantly if the need for power and the construction schedule are not optimized. (auth)

30290 (DOCKET-50003-108) INDIAN POINT STATION, UNIT 1. Loss of Coolant Analysis, Supplement 1. (Consolidated Edison Co. of New York, Inc., New York). Apr 1972. 157p. (SNE-111). Dep. NTIS.

30291 (DOCKET-50155-108) BIG ROCK POINT NUCLEAR PLANT. Technical Specifications, Request for Change 30. (Consumers Power Co., Jackson, Mich.). 21 Apr 1972. 13p. Dep. NTIS.

Revised technical specifications are presented concerning in-service inspection requirements for pressure vessel, cooling system, heat exchangers, and piping systems. (D.C.C.)

30292 (DOCKET-50155-109) BIG ROCK POINT NUCLEAR PLANT. Two Auxiliary Neutron Sources Found to be Corroded. (Consumers Power Co., Jackson, Mich.). 19 Apr 1972. 2p. Dep. NTIS.

30293 (DOCKET-50171-102) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Provisional Operating License DPR-12, Amendment 4. (Division of Reactor Licensing (AEC), Washington, D. C.). 20 Apr 1972. 4p. Dep. NTIS.

Authorization for the receipt, possession, and use of 25 grams of ^{239}Pu in test fuel elements is presented. (D.C.C.)

30294 (DOCKET-50219-179) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Facility Change Request 3. (Jersey Central Power and Light Co., Morristown, N. J.). 19 Apr 1972. 31p. Dep. NTIS.

Design parameters and operating limits for Type 3 fuel element assemblies are presented. Safety analysis for the core reload pattern is included. (D.C.C.)

30295 (DOCKET-50220-91) NINE MILE POINT NUCLEAR STATION, UNIT 1. Information Requested in Letter of March 21, 1972. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 21 Apr 1972. 11p. Dep. NTIS.

Requested additional information is presented concerning a revised scram reactivity curve. (D.C.C.)

30296 (DOCKET-50245-125) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Target Rock Relief Valves. (Millstone Point Co., Hartford, Conn.). 19 Apr 1972. 2p. Dep. NTIS.

30297 (DOCKET-50247-72) INDIAN POINT NUCLEAR GENERATING UNIT 2. Draft Detailed Statement on Environmental Considerations Related to the Proposed Issuance of an Operating License. (Division of Radiological and Environmental Protection (AEC), Washington, D. C.). 13 Apr 1972. 403p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Cost-benefit analysis for the reactor is included. (D.C.C.)

30298 (DOCKET-50254-31) QUAD-CITIES STATION, UNITS 1 AND 2. Request for Permission to Operate at Increased Power Level to Meet Expected Summer of 1972 Demand. (Commonwealth Edison Co., Chicago, Ill.). 12 Apr 1972. 98p. (DOCKET-50265-62). Dep. NTIS.

30299 (DOCKET-50254-82) QUAD-CITIES STATION, UNITS 1 AND 2. Energy Absorbing System on Fuel Pools. (Commonwealth Edison Co., Chicago, Ill.). 17 Apr 1972. 10p. (DOCKET-50265-63). Dep. NTIS.

30300 (DOCKET-50254-83) QUAD-CITIES STATION, UNITS 1 AND 2. Technical Specifications, Change 1. (Division of Reactor Licensing (AEC), Washington, D. C.). 19 Apr 1972. 5p. (DOCKET-50265-64). Dep. NTIS.

Revised technical specifications are presented concerning the lowering of the turbine-control-oil pressure scram set point from 1100 psig to 900 psig. (D.C.C.)

30301 (DOCKET-50254-85) QUAD-CITIES STATION, UNITS 1 AND 2. Environmental Report, Supplement 5. (Commonwealth Edison Co., Chicago, Ill). 24 Apr 1972. 8p. (DOCKET-50265-65). Dep. NTIS.

Additional information is presented concerning thermal discharges from the reactors. Modifications for the two unit spray canal are described. (D.C.C.)

30302 (DOCKET-50259-45) BROWNS FERRY NUCLEAR POWER STATION, UNITS 1, 2, AND 3. Additional Information Relating to the Design of Relief Valve Discharge Lines. (Ten-

nessee Valley Authority, Chattanooga). 14 Apr 1972. 1p. (DOCKET-50260–42; DOCKET-50296–39). Dep. NTIS.

30303 (DOCKET-50259–46) BROWNS FERRY NUCLEAR POWER STATION, UNITS 1, 2, AND 3. Environmental Radioactivity Levels, Semiannual Report, January–June 1971. (Tennessee Valley Authority, Chattanooga. Div. of Environmental Research and Development). Jun 1971. 32p. (DOCKET-50260–43; DOCKET-50296–40). Dep. NTIS.

30304 (DOCKET-50259–47) BROWNS FERRY NUCLEAR POWER STATION, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 26. (Tennessee Valley Authority, Chattanooga). 24 Apr 1972. 422p. (DOCKET-50260–44; DOCKET-50296–41). Dep. NTIS.

Design parameters and operating limits for the pressure vessel are presented. Proposed technical specifications are listed. Requested additional data are presented concerning design parameters and operating aspects of the reactors. (D.C.C.)

30305 (DOCKET-50263–117) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Environmental Report, Supplement 1. (Northern States Power Co., Minneapolis, Minn.). 4 Apr 1972. 115p. Dep. NTIS.

Information concerning chemical and thermal discharges from the reactor is presented. The effects of thermal discharges on the temperature distributions in the Mississippi River are described. (D.C.C.)

30306 (DOCKET-50266–64) POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2. Report PBR 3, Environmental Studies. (Wisconsin Univ., Milwaukee. Dept. of Botany). Apr 1972. 189p. (DOCKET-50301–53). Dep. NTIS.

For Wisconsin Electric Power Co., Milwaukee and Wisconsin Michigan Power Co., Appleton, Wis.

Information concerning radioactive and thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. Biological data for the reactor site are included. (D.C.C.)

30307 (DOCKET-50266–65) POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2. Information on Scram Circuit Breakers and Relief Valve Piping. (Division of Compliance (AEC), Glen Ellyn, Ill. Region III). 14 Jan 1972. 5p. (DOCKET-50301–54). Dep. NTIS.

30308 (DOCKET-50267–41) FORT ST. VRAIN NUCLEAR GENERATING STATION. Notice of Consideration of Issuance of Facility Operating License. (Division of Reactor Licensing (AEC), Washington, D. C.). 26 Apr 1972. 5p. Dep. NTIS.

30309 (DOCKET-50267–42) FORT ST. VRAIN NUCLEAR GENERATING STATION. Emergency Drill. (Division of Compliance (AEC), Denver, Colo. Region IV). 27 Apr 1972. 2p. Dep. NTIS.

30310 (DOCKET-50269–51) OCONEE NUCLEAR STATION, UNIT 1. Integrated Leak Rate Test of the Reactor Containment Building. (Duke Power Co., Charlotte, N. C.). 21 Apr 1972. 9p. Dep. NTIS.

30311 (DOCKET-50271–79) VERMONT YANKEE NUCLEAR POWER STATION. Facility Operating License, Amendment 1. (Division of Reactor Licensing (AEC), Washington, D. C.). 21 Apr 1972. 6p. Dep. NTIS.

Revised possession limits are presented for ^{235}U, ^{241}Am, and ^{124}Sb. (D.C.C.)

30312 (DOCKET-50272–25) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Construction Schedule Review. (Public Service Electric and Gas Co., Newark, N. J.). 8 Apr 1972. 2p. (DOCKET-50311–25). Dep. NTIS.

30313 (DOCKET-50272–26) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Analysis of Items of Nonconformance Identified in Letter Dated February 25, 1972. (Division of Compliance (AEC), Newark, N. J. Region I). 18 Apr 1972. 8p. (DOCKET-50311–26). Dep. NTIS.

Additional information is presented concerning the installation of embedded containment liner anchors, and welding equipment and procedures. (D.C.C.)

30314 (DOCKET-50277–30) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. License Application. (Philadelphia Electric Co., Pa.). 6 Feb 1967. 169p. (DOCKET-50278–36). Dep. NTIS.

Application for construction permit and operating license for Peach Bottom Power Reactor Units 2 and 3 is presented. The 1965 Annual Reports for the Philadelphia Electric Company, the Public Service Electric and Gas Company, the Delaware Power and Light Company, and the Atlantic City Electric Company are included. (D.C.C.)

30315 (DOCKET-50277–31) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Preliminary Safety Analysis Report, Additional Information to Amendment 1. (Philadelphia Electric Co., Pa.). 11 Jul 1967. 5p. (DOCKET-50278–37). Dep. NTIS.

A list of additions and revisions for the Preliminary Safety Analysis Report is presented. (D.C.C.)

30316 (DOCKET-50277–32) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Preliminary Safety Analysis Report, Additional Information to Amendment 5. (Philadelphia Electric Co., Pa.). 31 Oct 1967. 127p. (DOCKET-50278–38). Dep. NTIS.

Financial data on the owners of the Peach Bottom Power Reactor Units 2 and 3 are presented. The 1966 Annual Reports for the Philadelphia Electric Company, the Public Service Electric and Gas Company, the Delmarva Power and Light Company, and the Atlantic City Electric Company are included. (D.C.C.)

30317 (DOCKET-50277–33) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Final Safety Analysis Report, Additional Information to Amendment 7. (Philadelphia Electric Co., Pa.). 31 Aug 1970. 6p. (DOCKET-50278–39). Dep. NTIS.

Application for operating license for Peach Bottom Power Reactor Units 2 and 3 is presented. (D.C.C.)

30318 (DOCKET-50277–34) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Action to be Taken to Correct the Item of Nonconformance Noted in Letter of March 7, 1972. (Division of Compliance (AEC), Newark, N. J. Region I). 18 Apr 1972. 6p. (DOCKET-50278–40). Dep. NTIS.

Requested additional information is presented concerning the cleanliness of the pressure vessel interior during installation. (D.C.C.)

30319 (DOCKET-50277–35) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Preliminary Safety Analysis Report, Additional Information to Amendment 2. (Philadelphia Electric Co., Pa.). 14 Sep 1967. 3p. (DOCKET-50278–41). Dep. NTIS.

Additional information is presented concerning the design requirements for the torus ring header-piping systems. (D.C.C.)

30320 (DOCKET-50277–36) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Basic Data for Source Term Calculation. (Philadelphia Electric Co., Pa.). 27 Mar 1972. 10p. (DOCKET-50278–42). Dep. NTIS.

30321 (DOCKET-50280–74) SURRY POWER STATION, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 33. (Virginia Electric and Power Co., Richmond). 18 Apr 1972. 198p. (DOCKET-50281–72). Dep. NTIS.

Reliability tests are described and results are presented for the inside containment recirculation spray pump vertical induction motors. (D.C.C.)

30322 (DOCKET-50285–60) FORT CALHOUN STATION, UNIT 1. Final Safety Analysis Report, Amendment 34. (Omaha Public Power District, Nebr.). 27 Apr 1972. 243p. Dep. NTIS.

Revised design parameters of the Fort Calhoun Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. Revised performance evaluation of the emergency core cooling system is included. (D.C.C.)

30323 (DOCKET-50293–68) PILGRIM NUCLEAR POWER STATION. Corrective Action Taken in Resolving Problems Described in Letter of November 18, 1971. (Division of Compliance (AEC), Newark, N. J. Region I). 18 Apr 1972. 7p. Dep. NTIS.

Requested additional information is presented concerning engi-

neered safeguard system circuit breakers and installation procedures for electrical cables. (D.C.C.)

30324 (DOCKET-50298-30) COOPER NUCLEAR STATION. Preliminary Safety Analysis Report, Amendment 1, Part I. (Consumers Public Power District, Columbus, Nebr.). 1 Dec 1967. 193p. Dep. NTIS.

Revised and additional data are presented concerning design parameters and operations aspects of the reactor. (D.C.C.)

30325 (DOCKET-50305-36) KEWAUNEE NUCLEAR POWER PLANT. Supplementary Environmental Reports, Amendment 1. (Wisconsin Public Service Corp., Green Bay). 17 Apr 1972. 217p. Dep. NTIS.

Requested additional information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Biological data for the reactor site are included. (D.C.C.)

30326 (DOCKET-50305-37) KEWAUNEE NUCLEAR POWER PLANT. Steps Taken to Correct the Items of Apparent Nonconformance in Letter of March 13, 1972. (Division of Compliance (AEC), Glen Ellyn, Ill. Region III). 17 Apr 1972. 7p. Dep. NTIS.

Requested additional information is presented concerning wiring procedures and configurations for electrical cables. (D.C.C.)

30327 (DOCKET-50313-41) ARKANSAS NUCLEAR ONE, UNIT 1. Final Safety Analysis Report, Amendment 26. (Arkansas Power and Light Co., Little Rock). 21 Apr 1972. 147p. Dep. NTIS.

Revised design parameters of the Arkansas Nuclear One Power Reactor are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

30328 (DOCKET-50315-60) DONALD C. COOK NUCLEAR POWER PLANT, UNITS 1 AND 2. Environmental Report, Supplement 2. (Indiana and Michigan Electric Co., New York). 11 Apr 1972. 59p. (DOCKET-50316-60). Dep. NTIS.

Requested information concerning chemical and thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. Biological and hydrological data for the reactor site are included. Environmental aspects of transmission lines are described. (D.C.C.)

30329 (DOCKET-50317-46) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 20. (Baltimore Gas and Electric Co., Md.). 25 Apr 1972. 283p. (DOCKET-50318-45). Dep. NTIS.

Revised and additional data are presented concerning design parameters and operations aspects for the reactors. (D.C.C.)

30330 (DOCKET-50321-37) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Welding Procedures. (Georgia Power Co., Atlanta). 19 Apr 1972. 42p. Dep. NTIS.

30331 (DOCKET-50322-24) SHOREHAM NUCLEAR POWER STATION, UNIT 1. Present Status of Site Construction Program. (Long Island Lighting Co., Hicksville, N. Y.). 19 Apr 1972. 7p. Dep. NTIS.

30332 (DOCKET-50329-29) MIDLAND PLANT, UNITS 1 AND 2. Request Retention of Construction Exemption Dated July 30, 1970. (Consumers Power Co., Jackson, Mich.). 18 Apr 1972. 9p. (DOCKET-50330-28). Dep. NTIS.

30333 (DOCKET-50333-41) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Tabulation of Valves Used Within Reactor Coolant Pressure Boundary. (Power Authority of the State of New York). 12 Apr 1972. 6p. Dep. NTIS.

30334 (DOCKET-50333-42) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Evaluation of Effects of All Blowdown Forces Into the Torus on Structural Components. (Power Authority of the State of New York). 20 Apr 1972. 3p. Dep. NTIS.

30335 (DOCKET-50341-38) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Statement of Reasons Under Section 50.10 (d) and Answer to Show Cause Under Section 50.12 (b). (Detroit Edison Co., Mich.). 18 Apr 1972. 16p. Dep. NTIS.

Information concerning the legal aspects of the construction permit for the Fermi Power Reactor Unit 2 is presented. (D.C.C.)

30336 (DOCKET-50344-27) TROJAN NUCLEAR PLANT. Steps Taken to Correct Items in Letter of March 17, 1972. (Division of Compliance (AEC), Berkeley, Calif. Region V). 24 Apr 1972. 4p. Dep. NTIS.

Additional information is presented concerning cadwelds for reinforcing bars in the containment structure. (D.C.C.)

30337 (DOCKET-50348-38) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Statement of Reasons Why Construction Activities in Progress and Work Authorized Under Exemption Dated April 12, 1971 Should be Continued Pending Issuance of Construction Permit. (Alabama Power Co., Birmingham). 20 Apr 1972. 8p. (DOCKET-50364-32). Dep. NTIS.

30338 (DOCKET-50348-39) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Supplement to Environmental Report, Amendment 2. (Alabama Power Co., Birmingham). 17 Apr 1972. 32p. (DOCKET-50364-33). Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. Cost estimates for reactor operations are included. (D.C.C.)

30339 (DOCKET-50354-21) NEWBOLD ISLAND NUCLEAR GENERATING STATION, UNITS 1 AND 2. Why Site Preparation Activities Should be Continued Pending Issuance of a Construction Permit. (Public Service Electric and Gas Co., Newark, N. J.). 20 Apr 1972. 11p. (DOCKET-50355-21). Dep. NTIS.

30340 (DOCKET-50358-35) WILLIAM H. ZIMMER NUCLEAR POWER STATION, UNIT 1. 10CFR50 Changes Related to Site Preparations and Commencement of Construction. (Cincinnati Gas and Electric Co., Ohio). 19 Apr 1972. 5p. Dep. NTIS.

30341 (DOCKET-50361-22) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Preliminary Safety Analysis Report, Amendment 12. (Southern California Edison Co., Rosemead, Calif.). 18 Apr 1972. 248p. (DOCKET-50362-21). Dep. NTIS.

Additional geological and seismological data for the reactor site and surrounding area are presented. (D.C.C.)

30342 (DOCKET-50363-23) FORKED RIVER NUCLEAR GENERATING STATION, UNIT 1. Environmental Report, Amendment 1. (Jersey Central Power and Light Co., Morristown, N. J.). 18 Apr 1972. 138p. Dep. NTIS.

Geological, hydrological, and meteorological data for the reactor site is presented. Cost-benefit analysis of reactor operations is included. (D.C.C.)

30343 (DOCKET-50363-24) FORKED RIVER NUCLEAR GENERATING STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 15. (Jersey Central Power and Light Co., Morristown, N. J.). 21 Apr 1972. 6p. Dep. NTIS.

Additional financial data on the owners of the Forked River Power Reactor Unit 1 are presented. Cost estimates for the reactor are included. (D.C.C.)

30344 (DOCKET-50366-25) EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Statement Showing Cause Why Exemption for Certain Activities Prior to Issuance of a Construction Permit Should Not be Revoked. (Georgia Power Co., Atlanta). 19 Apr 1972. 13p. Dep. NTIS.

30345 (DOCKET-50366-26) EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Statement of Reasons Why Certain Ongoing Construction Activities Permitted Pursuant to 10 CFR 50.10(b) Prior to its Revision Should be Continued Pending Issuance of a Construction Permit. (Georgia Power Co., Atlanta). 19 Apr 1972. 24p. Dep. NTIS.

30346 (DOCKET-50368-26) ARKANSAS NUCLEAR ONE, UNIT 2. Statement of Reasons Why the Nuclear Construction Activities Presently Allowed Under an Exemption and in Progress Should not be Revoked Pending Issuance of a Construction Permit. (Arkansas Power and Light Co., Little Rock). 19 Apr 1972. 25p. Dep. NTIS.

30347 (DOCKET-50368-27) ARKANSAS NUCLEAR ONE, UNIT 2. Statement of Reasons Why the Nonnuclear Construction

Activities Presently in Progress Should be Continued Pending Issuance of a Construction Permit. (Arkansas Power and Light Co., Little Rock). 19 Apr 1972. 32p. Dep. NTIS.

30348 (DOCKET-50368-28) ARKANSAS NUCLEAR ONE, UNIT 2. Final Safety Analysis Report, Amendment 19. (Arkansas Power and Light Co., Little Rock). 19 Apr 1972. 65p. Dep. NTIS.

Financial data on the owners of the Arkansas Nuclear One Power Reactor Unit 2 are presented. The 1971 Annual Reports for the Arkansas Power and Light Company and the Middle South Utilities Incorporated are included. (D.C.C.)

30349 (DOCKET-50368-29) ARKANSAS NUCLEAR ONE, UNIT 2. Safety Evaluation by the Division of Reactor Licensing. (Division of Reactor Licensing (AEC), Washington, D. C.). 24 Apr 1972. 144p. Dep. NTIS.

30350 (DOCKET-50369-21) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. Statement Why Site Preparation Activities Should be Continued and Exemptions Should Not be Revoked Pending Issuance of Construction Permit. (Duke Power Co., Charlotte, N. C.). 20 Apr 1972. 13p. (DOCKET-50370-20). Dep. NTIS.

30351 (DOCKET-50369-22) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. Environmental Report, Revision 1 and Supplement 2. (Duke Power Co., Charlotte, N. C.). 1 May 1972. 77p. (DOCKET-50370-21). Dep. NTIS.

Specific requested information and additional data on the McGuire Nuclear Station environmental report are presented. The report is supplemented to indicate proposed plans for establishing the aquatic biota base line at the site, steps proposed to establish the adequacy of the analytical model used to predict the thermal plume at low lake levels, and details of a liquid radioactive waste model. (H.D.R.)

30352 (DOCKET-50376-31) AGUIRRE NUCLEAR PLANT, UNIT 1. Statement Showing Cause Why Current Site Preparation Activities Should be Continued. (Puerto Rico Water Resources Authority, San Juan). 18 Apr 1972. 10p. Dep. NTIS.

30353 (DOCKET-50382-21) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Statement of Reasons of Continuing Activities. (Louisiana Power and Light Co., New Orleans). 20 Apr 1972. 32p. Dep. NTIS.

A request for continuing site preparation activities pending the issuance of the construction permit is presented. (D.C.C.)

30354 (DOCKET-50395-17) VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 6. (South Carolina Electric and Gas Co., Columbia). 27 Apr 1972. 744p. Dep. NTIS.

Revised design parameters of the Virgil C. Summer Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

30355 (DOCKET-50397-15) HANFORD NO. 2 NUCLEAR POWER PLANT. Environmental Report, Amendment 3. (Washington Public Power Supply System, Richland). 17 Apr 1972. 73p. Dep. NTIS.

Additional information is presented concerning chemical, radioactive, and thermal discharges from the reactor. The effects of reactor operations on the environment are analyzed. Hydrological and meteorological data for the reactor site are included. (D.C.C.)

30356 (DOCKET-50397-16) HANFORD NO. 2 NUCLEAR POWER PLANT. Preliminary Safety Analysis Report, Amendment 5. (Washington Public Power Supply System, Richland). 17 Apr 1972. 145p. Dep. NTIS.

Revised design parameters of the Hanford Power Reactor Unit 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

30357 (DOCKET-50404-13) NORTH ANNA POWER STATION, UNITS 3 AND 4. Request to Continue Site Preparation Activity Pending Issuance of a Construction Permit. (Virginia Electric and Power Co., Richmond). 19 Apr 1972. 33p. (DOCKET-50405-13). Dep. NTIS.

30358 (DOCKET-50404-14) NORTH ANNA POWER STATION, UNITS 3 AND 4. Preliminary Safety Analysis Report, Amendment 3, Supplement Volume 1. (Virginia Electric and Power Co., Richmond). 21 Apr 1972. 437p. (DOCKET-50405-14). Dep. NTIS.

Revised and additional data are presented concerning design parameters and operation aspects for the reactors. (D.C.C.)

30359 (DOCKET-50404-15) NORTH ANNA POWER STATION, UNITS 3 AND 4. Preliminary Safety Analysis Report, Amendment 3, Supplement Volume 2. (Virginia Electric and Power Co., Richmond). 21 Apr 1972. 290p. (DOCKET-50405-15). Dep. NTIS.

Requested additional information is presented concerning design parameters and operations aspects of the reactors. (D.C.C.)

30360 (JUL-803-RG) PLANT CONCEPTS FOR NUCLEAR POWER PLANTS WITH HIGH-TEMPERATURE REACTOR AND HELIUM TURBINE CYCLE (HTR-GT). Foerster, S. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Oct 1971. 64p. (In German). Dep. NTIS (U. S. Sales Only).

Optimum design concepts for HTR power plants with gas-turbines are analyzed. Of main interest are plant concepts for cycle components integrated in the reactor concrete pressure vessel and externally arranged. The actual construction possibilities are described. 18 references. (auth)

30361 RELIABILITY EVALUATION BY PROBABILITY THEORY OF NUCLEAR REACTORS. Takekoshi, Tadasu (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Nippon Kikai Gakkaishi; 74: No. 633, 1312-17(Oct 1971). (In Japanese).

The safety evaluation of nuclear power plants is presented. The reliability of equipment is considered. The present state and development of safety evaluation techniques in foreign countries and Japan are reviewed. The difficulty involved in establishment of reliable evaluation techniques is mentioned, such as shortage of fault rate data for equipment and determination of criteria for risk judgment. Detailed discussion on the difficulty is given. The present methods in the world used to evaluate the reliability of equipment are given. (Japan)

30362 1160 MW TURBINE FOR DONALD C. COOK NUCLEAR POWER PLANT OF AEP. Hossli, W. (Brown, Boveri Co. Ltd., Baden, Switzerland). Brown Boveri Rev.; 59: No. 1, 4-19(Jan 1972).

Following some introductory comments on the reasons for building half-speed machines, the turbine for Donald C. Cook Power Reactor is described. Basic ideas which governed the designs adopted are described. The tests performed and special safety considerations are discussed. (3 references) (auth)

30363 1333 MVA GENERATOR FOR DONALD C. COOK NUCLEAR POWER PLANT OF AEP. Hiebler, H. (Brown, Boveri Co. Ltd., Baden, Switzerland). Brown Boveri Rev.; 59: No. 1, 20-9(Jan 1972).

The special features of this generator are described. The development work which preceded construction is briefly reviewed. Some comments on the transport facilities available for such workpieces are presented. (6 references) (auth)

30364 NEPA IMPACT ON NUCLEAR POWER PLANTS. Ellis, Glenn (Atomic Energy Commission, Washington, D. C.). Reactor Technol; 15: No. 1, 11-13(Spring 1972).

The National Environmental Policy Act (NEPA) is described in relationship to its effects on licensing of nuclear power plants. The review procedures and workloads imposed on the nuclear industries for implementation of NEPA requirements are discussed. (H.D.R.)

30365 RADIOACTIVE WASTE DISCHARGES TO THE ENVIRONMENT FROM NUCLEAR POWER FACILITIES. Logsdon, Joe E. (Environmental Protection Agency, Washington, D. C.). Radiat. Data Rep.; 13: No. 3, 117-29(Mar 1972).

Data relating to discharges of radioactive liquid and gaseous waste were compiled for 12 selected operating nuclear power facilities. These data are presented and compared to discharge limits and quantity of electric power produced. In most instances, concentration of radioactivity in waste discharge limits has been maintained at a few percent of the Atomic Energy Commission's licensed discharge limits. Exceptions are mostly associated with either an unusually high percentage of leaky fuel elements or with liquid discharge limits which are artificially low because liquid wastes, in some cases, are not analyzed for radionuclide content.

Comparison of power produced to liquid and gaseous waste discharges showed that boiling water reactors discharge relatively large quantities of gaseous waste and pressurized water reactors discharge relatively high quantities of tritium in liquid waste. No obvious trend is discernible concerning the quantity of radioactive waste discharged as a function of power generation. 16 references. (auth)

30366 DELAYS IN NUCLEAR PLANT LICENSING: CAUSES AND POSSIBLE SOLUTIONS. Ramey, James T. Pub. Util. Fortn.; 89: No. 7, 19-24(30 Mar 1972).

The argument that the U. S. is not striking the proper environment–energy balance in the licensing and regulation of nuclear power plants is presented. Some of the problems involved are reviewed and some possible solutions are discussed. (H.D.R.)

Propulsion and Auxiliary Power Reactors

30367 (ACF-403-62) KIWI-B-CF REACTOR AND CAR ASSEMBLY PROCEDURE. (AFC Industries, Inc., Albuquerque, N. Mex.). 6 Nov 1961. 57p. Dep. NTIS.

Declassified 8 Nov 1971.

A procedure manual is presented as a guide to the assembly of the KIWI-B-CF Reactor and test car at the Nuclear Rocket Development Station. (H.D.R.)

30368 (ACF-431-55) KIWI-B4B-CF: REACTOR AND CAR ASSEMBLY PROCEDURE. Fowler, James M. (ACF Industries, Inc., Albuquerque, N. Mex.). 8 Aug 1963. Contract AT(29-1)-1352. 82p. Dep. NTIS.

Declassified 28 Oct 1971.

A procedure manual is presented as a guide to the assembly of the KIWI-B4B-CF Reactor and test car at the Nuclear Rocket Development Station. (H.D.R.)

30369 (N-71-38238) ANALYTICAL STUDIES OF NUCLEAR LIGHT BULB ENGINE RADIANT HEAT TRANSFER AND PERFORMANCE CHARACTERISTICS. Rodgers, Richard J.; Latham, Thomas S.; Bauer, Harold E. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1971. Contract SNPC-70. 126p. (NASA-CR-123189; K-910900-10). NTIS.

A description is given of nuclear light bulb engine characteristics including engine performance, dynamics and control, heat loads, and shutdown. Design modifications to improve accessibility and reusability are also included. An analytical model for engine radiant heat transfer is outlined and analysis results are discussed. (STAR)

30370 (N-71-38239) EXPERIMENTS TO SIMULATE HEATING OF THE PROPELLANT IN A NUCLEAR LIGHT BULB ENGINE USING THERMAL RADIATION FROM A DC ARC RADIANT ENERGY SOURCE. Interim Summary Technical Report, September 16, 1970–September 15, 1971. Klein, John F. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1971. Contract SNPC-70. 71p. (NASA-CR-123199; ITR-2; K-910900-8). NTIS.

Experiments were conducted to simulate radiant heating of the propellant stream of a nuclear light bulb engine. A 500 kW dc arc was used as the radiant energy source and argon seeded with carbon particles was used to simulate the propellant. Unseeded buffer layers were used to prevent coating of the transparent duct walls. Methods were developed for introducing micro-sized carbon seeds into the central region of a three-stream flow in a rectangular duct to simulate a portion of the propellant stream. Simulated propellant bulk exit temperatures up to 3860°K were achieved. The bulk exit temperatures were determined by a calorimetric technique. The maximum bulk exit temperatures were limited primarily by vaporization of the carbon seeds and the amount of radiation incident on the test section. It is estimated that substantially higher propellant bulk exit temperatures can be obtained by improvements to the dc arc radiant energy source (in particular, improvement of the reflectivity of the mirrors used) and by the use of tungsten seeds which will remain in particle form to higher temperatures than carbon seeds. (auth) (STAR)

30371 (N-71-38240) EXPERIMENTAL INVESTIGATIONS TO SIMULATE THE THERMAL ENVIRONMENT AND FUEL REGION IN NUCLEAR LIGHT BULB REACTORS USING AN RF RADIANT ENERGY SOURCE. Interim Summary Technical Report, September 16, 1970–September 15, 1971. Roman, Ward C.; Jaminet, Jerome F. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1971. Contract SNPC-70. 99p. (NASA-CR-123192; ITR-2; K-910900-7). NTIS.

A description is given of the equipment and procedures utilized in radiant energy source, simulated fuel injection, transparent-wall model, and filament-wound pressure vessel studies. The rf induction heater simulation of the thermal environment and fuel region in nuclear light bulb type reactors is discussed including the testing of internally cooled transparent walls in a high-radiant-energy flux environment. The steady state power, chamber pressure, and radiation efficiency results for rf tests of a $\frac{2}{3}$-scale version of a possible in-reactor unit cell configuration are reported as well as power and chamber pressure results for models having peripheral walls constructed from thin-walled fused silica tubes. (STAR)

30372 (TID-14876) XMA-1 FRONT PLUG THERMODYNAMIC APPRAISAL, PHASE I. Final Report. Mills, Robert R. (Aircraft Armaments, Inc., Cockeysville, Md. General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.). May 1959. Contract AT(11-1)-171. 179p. (ER-1700). Dep. NTIS.

The results are presented of the investigations conducted during the Phase I program of the thermodynamic characteristics of the front plug configuration during the transient heating (startup), steady state, and transient cooling (shutdown) periods of operation. These results have been obtained from the THT computer analyses program. The thermodynamic characteristics of the front plug configuration are summarized. (auth)

30373 FLEXIBLE CORE REACTOR. Breidenbach, Gerard; Ross, Richard C. (to United States Atomic Energy Commission). U. S. Patent 3,625,818. 7 Dec 1971. Filed 17 May 1968.

An experimental flexible core reactor is described with segmented fuel and reflector regions for varying height and width of the core. The segments are layered with materials comprising the fuel, cladding, coolant, and structure to simulate during operation the effect on an operating reactor utilizing such materials. (Official Gazette)

30374 N. S. MUTSU, JAPAN'S FIRST NUCLEAR SHIP. RECORD OF THE PLANNING AND CONSTRUCTION ON THE HULL, ETC. Tokyo; Ishikawajima-Harima Heavy Industries Company Ltd. (1970). 467p. (In Japanese).

Special Issue of Ishikawajima-Harima Giho.

Main features of the N. S. Mutsu, with the main purpose of various navigational tests and subsequently of training nuclear ship crews, are as follows: the type of ship, freighter; the gross tonnage, 8,200 T; the number of crew, 79; the navigational speed, 16.5 kt; the PWR of 36 MW; and the hull size, 130 m × 19 m × 13 m (deep). Concerning the records of planning and construction on the hull etc., the following are described: the power plant (the primary and secondary systems, the electric power system and the instrumentation and control); radiation control (reactor containment vessel, radiation shields, radiation control facilities and wastes disposal); the hull and equipment (specifications, structures, and equipment and facilities); and the procedures of planning, construction, and inspection. (Japan)

30375 NUCLEAR REACTOR OF THE METAL HYDRIDE CONTROL TYPE. Magladry, Robert E. (to Teledyne, Inc.). U. S. Patent 3,644,173. 22 Feb 1972. Filed 6 Nov 1967.

A nuclear reactor comprises thermally isolated first and second sealed containers carrying metal hydride, one of which also includes nuclear fuel material with the metal hydride material forming essentially the reactor core, circulating coolant passages through the core containing container means for fluid connecting the sealed containers to allow intercontainer transfer of released hydrogen and means for heating the non-reactor core container to control reactivity within the reactor core. (Official Gazette)

Control and Instrumentation

30376 (N-71-35785) DESIGN STUDY OF A HIGH-FUEL FRACTION, EXTERNALLY-FUELED THERMIONIC DIODE SUITABLE FOR IN-PILE TESTING. Final Report. Ernst, Donald M. (Thermo Electron Corp., Waltham, Mass.). May 1971. Contracts NAS7-100; JPL-952469. 98p. (NASA-CR-121919; TE-5107-145-71). NTIS.

For Jet Propulsion Lab., Pasadena, Calif.

Results of the design study, including the critical component investigations, are summarized in detail. The preliminary design study showed, by thermal stress analysis, that with all other conditions equal, the stress considerations favor the unbonded emitter-fuel structure concept: there is no permanent deformation of any

of the components of the unbonded emitter-fuel structure, and the residual stress at room temperature after numerous thermal cycles is reduced to a minimum. However, since the all-bonded emitter-fuel structure has not only the advantage of lower ohmic losses, but also the capability of being tested with fuel in place, and since it has fewer components and is a two-material (rather than a four-material) system, three representative sample all-bonded emitter-fuel structures were fabricated and tested to investigate their structural integrity experimentally. Preliminary test results indicate that an all vapor deposited fluoride tungsten, all-bonded structure appears to be satisfactory from fabrication and operational points of view. (auth) (STAR)

30377 (N-71-35796) SNAP-8 REFRACTORY BOILER DEVELOPMENT PROGRAM: ANALYSIS AND TESTING OF A SINGLE TUBE MERCURY BOILER. Topical Report No. 7. Hsia, Edward S. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). Sep 1971. Contract NAS3-10610. 283p. (NASA-CR-72897; GESP-650). NTIS.

The results of an experimental investigation of heat transfer and fluid flow during forced convection boiling of wetted mercury in a single tantalum tube with composite vortex generator insert are presented. The experiments were conducted with a NaK-heated and highly-instrumented test section at mercury saturation temperature up to 1130°F. Exploratory local two-phase forced convection boiling results for mercury are presented for nucleate boiling, the critical heat flux condition, transition boiling and superheated vapor regions in a once-through boiling process. The experimental data and the associated correlations are directly applicable for the design and optimization of once-through boilers for Space Power Rankine Cycle Systems employing mercury as the working fluid. (auth) (STAR)

30378 (N-71-38247) DESIGN REVIEW OF THE BARE REFRACTORY DOUBLE-CONTAINMENT (BRDC) BOILER NUMBER 5 FOR PCS, SNAP 8. Chalpin, E. S. (Aerojet-General Corp., Azusa, Calif.). 22 Oct 1970. Contract NAS3-13458. 303p. (NASA-CR-72918; AGC-TM-7978:70-643). NTIS.

The design of the BRDC boiler no. 5 is presented. The boiler meets all defined interfaces and requirements of the power conversion system. Tantalum is used as the mercury containment material and type 300 stainless steels are used as the NaK containment material. Zirconium is employed at the mercury inlet and outlet sections as a gettering material for the dissolved gases in the static Nak and to minimize carbon transport from the type 300 stainless steel to the tantalum by gettering carbon. Coextruded tantalum-to-stainless steel transition joints (bimetal tubes) are used at the mercury inlet and outlet. (auth) (STAR)

30379 (N-71-38278) EFFECT OF SHIELD WEIGHT OF ADDING A FIXED-POSITION CONTAINMENT VESSEL IN THE UNIT SHIELD OF A 250-MEGAWATT MOBILE REACTOR. Wohl, Millard L.; Spielberg, David (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov 1971. 19p. (NASA-TM-X-2414; E-6462). NTIS.

The computer code UNAMIT was used to calculate optimized 4 pi-spherical, tungsten-water unit shield weights for three 250-megawatt reactors, a highly moderated, a lightly moderated, and a fast reactor. The effect on shield weight of the inclusion as part of the shield of a 1.39-meter (4.6-ft) inner radius refractory containment vessel of 5.08, 7.62, and 12.7 centimeter (2-, 3-, and 5-in.) thicknessess was calculated. The vessels were not optimally placed from a minimum shield weight point of view. The increases in shield weight due to inclusion of the vessels as part of the shields reflect the degree of nonoptimum placement of these thick layers of heavy material but were far less than the actual vessel weights. The vessels weighed 22,670, 34,900, and 59,800 kilograms (50,000, 77,000, and 132,000 lb). The total weight increase due to these vessels was 2,268, 5,890, and 15,420 kilograms (5,000, 13,000, and 34,000 lb), respectively. (auth) (STAR)

30380 (N-72-12601) SHOCK AND VIBRATION TESTS OF A SNAP-8 NaK PUMP. Stromquist, A. J.; Nelson, R. B.; Hibben, Lawrence (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Oct 1971. 18p. (NASA-TM-X-67945; E-6625). NTIS.

The pump used for reactor cooling in the SNAP 8 space power system was subjected to the expected vehicle launch vibration, and shock loading in accordance with the SNAP 8 environmental specification. Subsequent disassembly revealed damage to the thrust bearing pins, which should be redesigned and strengthened. The unit was operational, however, when run in a test loop after reassembly. (auth) (STAR)

30381 (N-72-12602) FLOW TESTS OF A SINGLE FUEL ELEMENT COOLANT CHANNEL FOR A COMPACT FAST REACTOR FOR SPACE POWER. Springborn, Roy H. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Oct 1971. 63p. (NASA-TM-X-67955; E-6651). NTIS.

Water flow tests were conducted on a single-fuel-element cooling channel for a nuclear concept to be used for space power. The tests established a method for measuring coolant flow rate which is applicable to water flow testing of a complete mockup of the reference reactor. The inlet plenum-to-outlet plenum pressure drop, which approximates the overall core pressure drop, was measured and correlated with flow rate. This information can be used for reactor coolant flow and heat transfer calculations. An analytical study of the flow characteristics was also conducted. (auth) (STAR)

30382 (N-72-12603) ON-LINE DIGITAL COMPUTER CONTROL OF THE NERVA NUCLEAR ROCKET ENGINE. Annual Report. Kendrick, Larry Ellis; Schultz, Donald G. (Arizona Univ., Tucson). Jun 1971. 191p. (NASA-CR-124647). NTIS.

The problem of on-line digital computer control of the NERVA nuclear rocket engine is considered. Proposed is a method of State Dependent State Variable Feedback (SDSVF) as a practical approach to the control of NERVA and other complex nonlinear and/or time-varying systems. The difficulties inherent in other design methods are avoided by defining the optimal closed loop system in terms of a desired transfer function, rather than a performance index to maximize or minimize. (auth) (STAR)

Operation and Economics

30383 (N-71-38277) LARGE NUCLEAR-POWERED SUBSONIC AIRCRAFT FOR TRANSOCEANIC COMMERCE. Rom, Frank E.; Masser, Charles C. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov 1971. 47p. (NASA-TM-X-2386; E-6271). NTIS.

Large subsonic aircraft, greater than 905 metric tons (1000 tons) gross weight, have the potential for hauling transoceanic cargo at rates in the range of $0.006 to $0.036 per metric ton-kilometer ($0.01 to $0.06/ton-n mi) at speeds of 740 to 925 kilometers per hour (400 to 500 knots). It theoretically would take a fleet of 500 such aircraft to handle 1 percent of the forecast world ocean trade in 1980. For gross weights of 3620 metric tons (4000 tons) the cargo rate would be reduced to less than $0.012 per metric ton-kilometer ($0.02/ton mi). It theoretically would take a fleet of over 1000 such aircraft to carry 8 percent of the world's transoceanic trade projected for 1980 or 4 percent of the projected trade in 1995. Aircraft with a gross weight of 3620 metric tons (4000 tons) using compact lightweight nuclear reactors show better performance than chemical aircraft for ranges greater than 5565 kilometers (3000 n mi). Nuclear aircraft performance is less sensitive than that of chemical aircraft to the operating and cost assumptions used. Relatively large variations in any of the important assumptions have a relatively small effect on nuclear aircraft performance. (auth) (STAR)

30384 (N-72-12604) AIRBREATHING NUCLEAR PROPULSION: A NEW LOOK. Rom, Frank E. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Dec 1971. 26p. (NASA-TM-X-2425; E-6316). NTIS.

Nuclear-powered air-cushion vehicles using lightweight aircraft-type nuclear powerplants show promise of carrying transoceanic cargo at cost-per-metric-ton-kilometer (cost-per-ton-n mi) rates comparable to railroad rates. These rates are independent of the distance traveled. Cargo rates for nonstop distances of 4000 n mi are expected to be less than one-half those for similar fossil-fueled air-cushion vehicles. For 6000-n mi nonstop distances, the rates are expected to be less than one-sixth as much. There are no fundamental technical reasons why subsonic nuclear aircraft cannot be made to fly successfully if the gross weight is over 1 million lb. Public safety of airborne nuclear powerplants is receiving the greatest attention in low-level experimental and analytical investigations. Idealized model containment vessels which have been impacted on reinforced concrete showed no leaks after impact at velocities to 400 mph. The experiments indicate feasibility of impacting at speeds over 600 mph with no leaks. (auth) (STAR)

Safety

30385 (N-71-35233) ANALYSIS OF A 35- TO 150-KILOWATT BRAYTON POWER-CONVERSION MODULE FOR USE WITH AN ADVANCED NUCLEAR REACTOR. Kerwin, Paul T. (National

Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sep 1971. 28p. (NASA-TN-D-6525; E-6352). NTIS.

Reference parameters were selected for a Brayton power-conversion module with a turbine inlet temperature of 1144°K (2060°R) to be used in a nuclear-reactor-powered system capable of producing up to 450 kilowatts electric. Unshielded system specific weight is 90 lb/kW(e) with a specific radiator area of about (30 square feet per kW(e) at full power. (auth) (STAR)

30386 (N-71-38248) EVALUATION OF SNAP-8 ALTERNATOR P/N 094069, S/N 481490 AFTER 23130 HOURS OF ENDURANCE TESTING IN THE ELECTRICAL COMPONENT TEST FACILITY (ECTF). Foley, R. S. (Aerojet-General Corp., Azusa, Calif.). 9 Jun 1970. Contract NAS3-13458. 128p. (NASA-CR-72920; AGC-TM-3710:71-650). NTIS.

An alternator was used for endurance testing simultaneously with a drive adapter consisting of a housing, shaft, bearings, and other parts. This arrangement made a simple coupling between the gearbox drive and the alternator and enabled endurance tests to be conducted on the turbine bearings as well as on the alternator. The testing arrangement is shown. Testing was done to determine if there were any weaknesses in the alternator and other electrical components which would show up under long term testing. The alternator and drive adapter were examined after endurance testing to evaluate the causes for test termination. (auth) (STAR)

30387 (N-71-38252) PRELIMINARY DESIGN OF MK 70 REACTION TURBINE FOR SNAP-8 90 kWe SYSTEM. Waters, W. (Aerojet-General Corp., Azusa, Calif.). 27 May 1971. Contract NAS3-13458. 276p. (NASA-CR-72919; AGC-TM-3710:71-651). NTIS.

The preliminary design for the reaction turbine was completed. A turbine configuration was selected which will yield a minimum turbine efficiency of 78% (total to static). Two configurations were found to be satisfactory. Both used dual and opposed turbine assemblies mounted on the same shaft. This introduced the total system flow at the center of the turbine assembly and allowed half to flow away from the inlet manifold through each of the two assemblies. Thus the net axial loads from stage reaction were effectively cancelled. The recommended turbine configuration employs a single radial inflow impeller to replace the two initial stages of each half of an axial flow turbine. The symmetrical impeller accepts total system flow at the inlet, but within the impeller, the flow is halved with each half discharging axially in opposite directions to continue expansion through axial flow stages. A bearing life of at least five years can be expected. (auth) (STAR)

Process Heat and Desalination Reactors

Refer also to abstract 27992.

30388 DESIGN OF A MILLION-GALLONS-PER-DAY MSF DESALINATION PLANT FOR COMBINATION WITH A 456 MWth HEAVY WATER NUCLEAR POWER REACTOR. Kamal, Ismat (Pakistan Atomic Energy Commission, Karachi). Nucleus (Karachi); 8: No. 3, 37-48(Jul-Sep 1971).

The theoretical possibility of the use of an extraction cycle for the combination of a million gallons per day, multi-stage flash (MSF) desalination plant with the 456 MH(t) Heavy Water Nuclear Power Reactor under construction near Karachi is analyzed. The optimum performance ratio of the plant is shown to be 6.2 and the optimum number of stages is deduced as 25. Details of plant design including chamber geometry, heat transfer surface requirements, etc., are given. It is concluded that the desalination plan could be attached to the KANUPP with a minor effect on the running cost of the plant. 12 references. (auth)

30389 ATOM UTOLYAET ZHAZHDU. IZDANIE VTOROE, PERERABOTANNOE I DOPOLNENNOE. (Atom Quenches Thirst. Second Edition, Revised and Enlarged). Kolychev, B. S. Moscow; Atomizdat (1970). 113p.

The different methods of distillation which have been proposed for use with nuclear reactors are described. The costs of energy and the freshwater produced are examined in connection with nuclear-electric power installations. Various reactor types and their relative advantages are analyzed. 16 references. (K.S.W.)

Research and Test Reactors

Refer also to abstracts 28536, 28582, 28612, 30189, and 30257.

30390 (AED-CONF-71-100-14) ACCELERATOR BOOSTER RESEARCH REACTOR: A USEFUL TOOL FOR SMALL LABORATORIES. Beckurts, K. H.; Eckert, H. G.; Kuechle, M.; Scharmer, K.; Wuerz, H. (Kernforschungszentrum, Karlsruhe (West Germany)). May 1971. 11p. (CONF-710901-519). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The operating characteristics of a linear accelerator boosted research reactor are presented. The target of the accelerator is placed in the center of a small fast reactor core whose reactivity is modulated so as to have high multiplication during neutron injection and low multiplication between successive pulses to suppress background. The fast neutrons leaking out from the core are thermalized in hydrogenous moderators located in the reflector surrounding the core. Design characteristics for a 100 kW accelerator booster are described. (9 references) (D.C.C.)

30391 (FIND-1(4-72)) FIND: POWER BURST FACILITY. Smith, James G. (ed.) (Technical Information Center (AEC), Oak Ridge, Tenn.). 14 Apr 1972. 12p. Dep. NTIS.

An index to microfiche issuances of safety analysis reports is provided. Subject citations are to specific frames on the microfiche. (J.M.J.)

30392 (INR-1344) THERMAL NEUTRON PARAMETERS OF THE SUBSTITUTED WWR-SM LATTICE CONTAINING BERYLLIUM MODERATOR. Jozefowicz, E. T.; Kilim, S. (Institute of Nuclear Research, Warsaw (Poland)). 1971. 13p. Dep. NTIS (U. S. Sales Only).

The substituted lattice containing WWR-SM fuel elements and beryllium fillers was constructed in MARYLA-2 critical assembly to check the behavior of the thermal cell code S-III-THERMOS in the cell containing beryllium. Thermal neutron microdistribution and thermal spectrum index Lu : Dy were measured and compared with calculations. Satisfactory agreement was achieved. (10 references) (auth)

30393 (JAPFNR-15) FAST BREEDER REACTOR DEVELOPMENT IN JAPAN. Quarterly Progress Report, September-November 1971. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Translation of a Japanese report. 8p. Dep. NTIS (U. S. Sales Only).

The construction and component testing programs for the Japanese Experimental Fast Reactor are reviewed. Design characteristics and physics measurements for the Japanese Prototype Fast Breeder Reactor are analyzed. (D.C.C.)

30394 OUTLINE OF THE FAST NEUTRON SOURCE REACTOR OF UNIVERSITY OF TOKYO. An, Shigehiro (Tokyo Univ.). Gakujutsu Geppo; 23: No. 12, 39-43(Mar 1971). (In Japanese).

In the University of Tokyo, a three year program for construction of a Fast Neutron Source Reactor has been under way since 1968. The program aims at setting up a facility for fundamental research and training, oriented in particular toward the field of fast and intermediate neutron research. The Fast Neutron Source Reactor is expected to possess many properties required of such a facility. The reactor is a development of Harmonie and AFSR, that is, air cooled, 93% enriched metal uranium fueled type, modified to enhance flexibility for research and training. Principal features, a general description of the reactor, and examples of project headings in research programs are reported. (Japan)

30395 MEASUREMENTS OF GAMMA-HEAT IN THE JMTR. Hayashi, Takao; Andoh, Hiroe; Takahashi, Hidetake; Onodera, Kazuyuki (Japan Atomic Energy Research Inst., Oarai). J. Nucl. Sci. Technol. (Tokyo); 9: No. 3, 133-42(Mar 1972).

On-power (30 MW) measurements of γ-heat in core have been carried out as part of a reactor characteristics measurement program during the first cycle of operation of the Japan Material Testing Reactor (JMTR). Two original types of calorimeters, A-type (metal rod principle, permitting self-contained calibration) and B-type (gas dumping principle) specially adapted to measurement in the JMTR were designed and used successfully. Guide tubes were installed in the reactor, through which the probes were inserted and moved in the core for measuring the distributions of γ-heat rates. Measurements were undertaken on six selected core lattices by exchanging and transferring the probes. The spatial distributions of γ-heat in the core lattices and their changes in the course of the time through the cycle were thus measured. A discussion is given on the principles embodied in the calorimeters, their practical design, and measurements made therewith in the reactor. 15 references. (auth)

30396 THERMAL COEFFICIENT OF REACTIVITY AND EFFICIENCY OF COMPENSATION RODS FOR THE REACTOR IGR. Lavrenikov, V. D. At. Energ. (USSR); 32: No. 1, 58-60 (Jan 1972). (In Russian).

The IGR is a homogeneous U-graphite reactor without a cooling system or metal construction so that its core may attain temperatures as high as 1,400°K. The thermal coefficient of reactivity was determined while the reactor operated on a burst cycle. In measuring the effectiveness of the compensator rods, their displacement was measured following each burst. The data are plotted on suitable graphs and the results are discussed. (K.S.W.)

30397 STATIC AND DYNAMIC EXPERIMENTS WITH A REPETITIVELY PULSED NEUTRON BOOSTER. Mihalczo, John T. (Union Carbide Corp., Oak Ridge, Tenn.). Nucl. Sci. Eng.; 47: No. 3, 290-301(Mar 1972).

A series of dynamic measurements were performed with a multiplying assembly in which a rotating beryllium reflector (worth 4.8 dollars in reactivity) moved past an unreflected core surface ~60 times/sec at a speed of 264 m/sec. A pulse of 14.1-MeV neutrons was injected into the assembly each time the rotating reflector attained a position for which the reactivity of the assembly was maximum. The time distribution of neutrons after the injection of the pulse was measured in the core and adjacent to a 10.16- × 10.16- × 3.81-cm polyethylene scatterer which provided a pulse of thermal leakage neutrons. The maximum prompt-neutron multiplication of the assembly, which was reflected with iron on all sides but one and contained 58.6 kg of highly enriched uranium metal at delayed criticality, was varied from 75 to 285 by fuel loading changes. This assembly with a maximum prompt-neutron multiplication of 285 produced fast-neutron pulses with a width at half-maximum of 3.9 μsec, with a peak-to-minimum ratio of 12,400 and with 80% of the power in the pulse. These pulses, when thermalized by the scatterer, were broadened to a width at half-maximum of 20.9 μsec with a peak-to-minimum power ratio of 1590. The number of thermal neutrons leaking from the outer surface of the scatterer was 3.3×10^{-5} n/(cm^2 fission). 18 references. (auth)

30398 VOID COEFFICIENT OF REACTIVITY FOR THE RESEARCH REACTOR FRG. Buenemann, D.; Kolb, M.; Krull, W.; Ramsel, H.-J. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Atomkernenergie; 19: No. 2, 97-100(Apr 1972). (In German).

The void coefficient of reactivity is of special interest for safety considerations at increased power of the research reactor FRG at Geesthacht. The void content was realized at a core mockup in the critical facility ANEX by means of flooding and voiding of thin in-core polyethylene tubes in variable numbers, and the reactivity was determined from the asymptotic reactor period. It was possible to demonstrate for increasing void contents that the reactivity depends in a slightly nonlinear way on the void volume due to second order perturbation effects. Model calculations by means of a 4 group-diffusion code in x-y-geometry reproduce the experimental results. The results of the reactivity perturbation calculations using these exactly calculated perturbed fluxes in a first order "one-group"-perturbation expression are in good agreement with the measurements as well. (8 references) (auth)

30399 THERMAL NEUTRON SPECTRUM IN A REACTOR CORE WITH MTR TYPE FUEL ELEMENTS. Anuschewski, P.; Krull, W.; Lahann, H.-J.; Mertins, H.; Taha, M. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Atomkernenergie; 19: No. 2, 171(Apr 1972). (In German).

The thermal neutron spectrum was measured experimentally. For computation of the distribution of thermal neutrons, a multiple group transport equation was used which was solved with the Monte Carlo method. Experimental and computed values agreed moderately well. Generally, computed neutron temperatures were higher than measured values. Reasons for discrepancies were analyzed. Theory and experiments yielded, for the most part, the same qualitative behavior and the data fell within error limits inherent in the theoretical and experimental procedures. (H.B.G.)

30400 FUTURE FOR THE ESSOR PLANT? Bonnaure, P. (CCR–EURATOM, Ispra, Italy). Energ. Nucl. (Milan); 19: No. 4, 223-35(Apr 1972).

Following a large effort intended to fit the ESSOR plant to the irradiation programs presently interesting the European nuclear industry, this installation is now available to the groups or organizations concerned with the development of light water, heavy water and high temperature reactors. The possibilities in this frame offered by this plant, integrating a large test reactor and high activity laboratories, are discussed. (auth)

30401 TOKYO UNIVERSITY FAST NEUTRON SOURCE REACTOR YAYOI PROJECT. At. Jap.; 15: No. 5, 20-6(May 1971).

In implementing the national program on nuclear reactor development, a need for some facility yielding fast neutron fields was evident. To meet this need, the Fast Neutron Source Reactor in the University of Tokyo was designed, and on April 10 it attained criticality after three years of construction. The reactor, named "YAYOI", was designed for generation of fast, intermediate, or thermal neutron energy spectra independently, and equipped with various kinds of openings for spectroscopic research. "YAYOI" has a maximum thermal output of 2kW, and maximum neutron flux of 0.8×10^{12} n/cm^2 sec. The reactor core comprises three disks of 93w/o ^{235}U metallic uranium fuel, total weight of which is about 25 kg. "YAYOI" possesses some novel features compared with other fast neutron source reactors, such as AFSR in the U.S.A. or HARMONIE in France. Principal features and a general description of "YAYOI" are presented. Moreover ancillary experimental equipment and some examples of research programs using "YAYOI" are reported. (Japan)

30402 REACTOR FREQUENCE RESPONSE BASED ON PULSED NEUTRON TECHNIQUES. Moen, Donald Albert. Ames, Iowa; Iowa State Univ. (1971). 147p. University Microfilms Order No. 72-5238.

Thesis.

A method was developed for deducing reactor frequency response from a pulsed neutron technique and an experiment was performed to determine the space-dependent frequency response of the Iowa State University UTR-10 reactor. The experiment was designed in such a way that it provided quantitative comparisons with two analytical models of the UTR-10 developed previously at Iowa State University, and provided a qualitative comparison with a third such model. In addition, the experiment was modeled with the WIGLE code. The coupled core, slab geometry UTR-10 was excited with a Kaman Nuclear model A-800 pulsed neutron generator and the time response observed with conventional instrumentation. Subcritical configurations with negative reactivities of approximately $2.00 and $3.00 were investigated and frequency response functions (Bode plots) were deduced for three different locations within the reactor. Frequency response was extracted from the time domain data through a numerical Fourier transformation. It was found, however, that statistical scatter in the early part of the time function produced unacceptable scatter in the frequency domain at high frequencies. To overcome this problem, a data smoothing algorithm was developed and its operation evaluated using a series of test cases wherein the experimental scatter was modeled and introduced into mathematically smooth functions. The nature of the models used and the meanings of the comparisons obtained are discussed. All models were in excellent agreement with experiment at low frequencies but some disparity did appear at frequencies above approximately 1000 rad/sec. Both models and experiment displayed evidence of phenomena relating to the coupled core feature of the UTR-10. (Diss. Abstr. Int., B)

Control and Instrumentation

Refer also to abstracts 27973, 30195, 30212, and 30251.

30403 (ORNL-TM-3679(Vol.2)) REACTOR ON-LINE COMPUTER CONTROL DEVELOPMENT AT THE HFIR. VOL. 2. PROGRAM LISTINGS, SUMMARIES, AND LOGIC DIAGRAMS. Bullock, J. B.; Owens, G. R.; Sides, W. H. Jr. (Oak Ridge National Lab., Tenn.). 18 Feb 1972. 423p. Dep. NTIS.

The computer programs written for the HFIR reactor computer control and surveillance system are presented in three levels of detail. The programs are described in summary form and in logic diagram form, and finally the detailed assembly language listing is presented along with the hexadecimal machine instructions. 8 references. (auth)

30404 (ORNL-TM-3705) FFTF RELATED STUDIES IN THE ORNL-LMFBR SHIELDING PROGRAM. Mynatt, F. R.; Clifford, C. E.; Muckenthaler, F. J.; Maerker, R. E.; Gritzner, M. L.; Williams, L. R.; Rathbun, J. L. (Oak Ridge National Lab., Tenn.). 27 Mar 1972. 53p. Dep. NTIS.

The progress to date on neutron transport calculational studies of FFTF shielding design is presented, including the analysis of supporting integral experiments. The major FFTF shielding problems considered were the predictions of neutron dose rates above the reactor head and neutron fluence intensities at the core support grid plate. (6 references) (auth)

30405 CALORIMETERS FOR CRITICAL ASSEMBLIES. Gerashchenko, O. A.; Klimentov, V. B.; Nikonov, A. V. At. Energ. (USSR); 32: No. 3, 232-4(Mar 1972). (In Russian).

The direct determination of heat release in critical assemblies was accomplished with a highly sensitive calorimeter, the design of which is described in detail. A Ni thimble within the calorimeter contained 90% enriched UO_2 pellets. Outside the thimble was a laminated thermoelement connected externally to a potentiometric apparatus where the emf could be measured. With a neutron flux of 3.6×10^7 n/cm^2 · sec at the surface of the calorimeter, the heat release by the UO_2 pellets (dia 0.9 cm, height 4 cm) within the calorimeter was 34×10^{-4} W/cm^3. A procedure for use of the calorimeter is outlined. (K.S.W.)

30406 REFUELING EQUIPMENTS FOR FAST BREEDER REACTORS. Hotta, Osamu (Fuji Electric Co. Ltd., Kawasaki, Japan). FAPIG (Tokyo); No. 62, 78-82; 89(Aug 1971). (In Japanese).

Characteristics and difficulties concerning refueling equipment for various fast breeder reactors being developed in the world are presented. Major components, mechanism and techniques related with the refueling equipment are described. The research and development work to be done for the refueling equipment of a research fast breeder reactor being constructed in Japan is introduced. (Japan)

30407 NEUTRON BEAM GUIDE AND EXTERNAL NEUTRON LABORATORY OF A COLD NEUTRON SOURCE. Bauer, G.; Joswig, G.; Schelten, J.; Schmatz, W. (Inst. fuer Festkoerperforschung, Juelich, Ger.). Kerntechnik; 14: No. 1, 9-12(Jan 1972). (In German and English).

An intense neutron beam from a cold source is made available to six different neutron scattering experiments by means of neutron guide tubes. The overall layout and important engineering details of these facilities are described. (3 figures) (auth)

Operation and Economics

30408 (BLG-460, pp 7,1-29) MATERIALS TESTING REACTOR BR2 AND ASSOCIATED FACILITIES. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 1970.

In Annual scientific report, 1970.

BELGIAN REACTOR-2—operation during 1970, summary of
—experimental facilities at, summary of 1970 use of
—maintenance during 1970, summary of (H.D.R.)

30409 (BLG-460, pp 9,1-11) TECHNICAL SUPPORT. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 1970.

In Annual scientific report, 1970.

30410 (BNL-tr-473) DEVELOPMENT AND APPLICATION OF THE IBR PULSED REACTOR IN SCIENTIFIC RESEARCH. Frank, I. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report JINR-P3-5754. 87p. Dep. NTIS.

The first 10 years of operation of the IBR reactor are reviewed. Basic achievements of research before and after the addition of the microtron injector are described, and the prospects for future achievements are discussed. (H.D.R.)

30411 (GEAP-10010-30) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR DEVELOPMENT PROGRAM. Quarterly Report No. 30, August-October 1971. Pflasterer, G. R.; Becker, R. A. (comps.) (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Nov 1971. Contract AT(04-3)-540. 100p. Dep. NTIS.

PRESSURE VESSELS—stress analysis for fast test reactor
REACTOR FUEL ELEMENTS—fabrication of instrumented plutonium oxide (PuO_2)-uranium oxide (UO_2) rods
SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR—control elements for, fabrication of Core 2 super prompt FRED tests
—fuel elements for, fabrication of Core 2 instrumented plutonium oxide (PuO_2)-uranium oxide (UO_2)
—critical transients for Core 1, analysis of super prompt
—reactivity worth of Core 2
—operation of, revised technical specifications for
—pressure vessel for, stress analysis for
—maintenance during August to October 1971
—operations during August to October 1971 (D.C.C.)

30412 (ORNL-TM-3784) OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT, OCTOBER, NOVEMBER, AND DECEMBER OF 1971. Tabor, W. H.; Hurt III, S. S. (Oak Ridge National Lab., Tenn.). 27 Mar 1972. 40p. Dep. NTIS.

The ORR was in service 88.7% of the time during October, November, and December of 1971. The average power level during operation was 29.9 MW, resulting in a total energy production of 2,441 MWd. Fuel usage remained quite satisfactory, as the average burnup (consumption of ^{235}U) for those elements depleted during the quarter was 51.8% as compared with an average of 49.5% for calendar year 1970. An increase in shim rod utilization is evidenced by the increased burnup of shim-rod elements (~76% as compared with ~64% for calendar year 1970). Reactor downtime totaled approximately 250 hrs of which only 0.233 hrs was unscheduled. End-of-cycle shutdowns comprised 86% of the total downtime, with the remainder used principally for refueling and experiment work. Instrumentation for the reactor and the associated process sytems functioned quite satisfactorily with, generally, only routine maintenance requirements. Two ionization chambers required replacement (No. 2 safety and noise monitor); however, the chamber for the noise monitor had been in service for approximately nine years. Alterations to the normal off-gas (NOG) filter system were completed, providing satisfactory drainage for the filter boxes and adequate sampling points to facilitate efficiency tests. (auth)

Safety and Siting

Refer also to abstract 30248.

30413 (KFK-1348) CRITERIA FOR DIFFERENTIATION OF FUEL AND PLENUM DEFECTS IN REACTOR FUEL ELEMENTS WITH VIBRATIONALLY LOADED FUEL. Golly, W.; Jacobi, S. (Kernforschungszentrum, Karlsruhe (West Germany). Labor fuer Elektronik und Messtechnik). Oct 1971. 44p. (In German). Dep. NTIS (U. S. Sales Only).

For research with failed fuel elements the HSD-Loop was installed at the FR 2. The operation with two pins of the HDR-type is described. The pins were failed in the fuel region and at the plenum. Criteria are specified to discriminate these two types of defect by means of a precipitator. (10 references) (auth)

30414 (ORNL-TM-1981(Rev.1)) HEALTH PHYSICS AND SAFETY GUIDELINES FOR THE DOSAR FACILITY. Kerr, G. D.; Poston, J. W.; Robinson, E. M. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 17p. Dep. NTIS.

30415 ERRORS DURING MEASUREMENT OF TOTAL CROSS SECTIONS WITH THE GEESTHACHT NEUTRON SPECTROMETER. Suszkin, A. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Atomkernenergie; 19: No. 2, 172(Apr 1972). (In German).

To determine the measuring accuracy of the Geesthacht neutron spectrometer, two series of repetitive measurements of total cross sections were performed on copper and hydrogen in dioxane. In addition to repetitive measurements at constant neutron energies, the dependency of the total cross section of copper on neutron energy was measured 23 times in the range from 0.033 to 0.33 eV. Mean cross section variation was 0.097 barn, corresponding to 0.9%. During repetitive measurements, sudden drastic increases in error occurred in about 3 out of 50 measurements. These drastic errors were probably caused by epithermal neutrons originating from the floor of the reactor building or from adjacent experimental stations. (H.B.G.)

Production Reactors

30416 (TID-5416) COMPONENT ASSEMBLY EQUIPMENT. NYX Test Nos. 2.8.1, 2.9.2. Bernath, L.; Thompson, J. E. (Du Pont de Nemours (E. I.) and Co., Wilmington, Del. Atomic Energy Div.). Feb 1953. Contract AT(07-2)-1. 29p. (DPXN-232). Dep. NTIS.

Declassified 19 Oct 1971.

The NYX testing of the Savannah River Plant prototype component assembly equipment comprised repeated operation of the quatrefoil loading machines, the loading magazines, and the tipping table to evaluate the suitability of these machines to perform their design function with reliability and convenience of operation. During testing, both design and operational deficiencies were found and corrected in the NYX equipment. In general, the equipment operated satisfactorily after modification. (9 references) (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 27994, 27999, 28535, 28539, 28544, 28547, 28552, and 28606.

30417 FUEL SUBASSEMBLY FOR NUCLEAR REACTOR. Noyes, Richard C.; Andrews, Mena G. (to United States Atomic Energy Commission). U. S. Patent 3,629,061. 21 Dec 1971. Filed 15 May 1969.

A nuclear fuel subassembly comprises a shroud for enclosing fuel, the walls of the shroud containing spaces for carrying neutron moderating material. A honeycomb for lending structural rigidity is sandwiched in the walls of the shroud, the spaces in the honeycomb containing the neutron moderating material. (Official Gazette)

30418 MOISTURE MONITOR FOR REACTOR PIPING. Hawkins, W. M. Jr. Power Eng.; 76: No. 3, 56-7(Mar 1972).

A method for remotely detecting moisture leaks from pipes, particularly in nuclear power plant piping systems, is described. An adhesive electrical conducting tape, whose conductivity is dependent on its moisture content, is applied to insulation around the pipes, flanges, and welds in the piping system. Small moisture seepage activates the tape which results in a signal to a continuously-operating remote monitoring station. This equipment was used in installations as early as 1959 and in 1969 was awarded a patent as a system for monitoring moisture leakage in power reactors. (L.C.L.)

30419 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ELEMENT ASSEMBLIES. (to Babcock and Wilcox Co.). British Patent 1,264,639. 23 Feb 1972. Priority date 7 Nov 1968, United States.

REACTOR FUEL ELEMENTS— spacer grid for, design of flexible (H.D.R.)

30420 IMPROVEMENTS RELATING TO IRRADIATION SURVEILLANCE APPARATUS FOR NUCLEAR REACTORS. (to Combustion Engineering, Inc.). British Patent 1,263,657. 16 Feb 1972. Priority date 6 Jun 1969, United States.

RADIATION TARGET CANS— design of interconnected, for reactor materials irradiation surveillance (H.D.R.)

30421 TRUD: AN ANISOTROPIC DIFFUSION CODE COMPUTING THE DIFFUSION COEFFICIENTS IN X Y GEOMETRY. CHARACTERISTICS AND RESULTS. Daneri, A. (CNEN, Bologna); Michelini, M.; Toselli, G. Energ. Nucl. (Milan); 19: No. 2, 83-90(Feb 1972).

An anisotropic diffusion model is described by which the coefficients D_x, D_y, D_z in generalized XY geometry can be calculated more accurately than by classic techniques. The results obtained for some problems of physical interest are reported and compared with those obtained by S_n transport and classic diffusion codes. (13 references) (auth)

30422 METHOD OF ROTATING AN IRRADIATION RABBIT IN A NUCLEAR REACTOR PNEUMATIC TUBE CONVEYOR. (to Commissariat a l'Energie Atomique). British Patent 1,263,679. 16 Feb 1972. Priority date 20 Jan 1970, France.

RADIATION TARGET CANS— rotation in reactor core position of pneumatic tube conveyor, compressed air system for

REACTOR EXPERIMENTAL FACILITIES— rabbit tubes for, compressed air system for rotation of target can in (H.D.R.)

30423 ENGINEERING DESIGN OF NUCLEAR REACTOR CONTROLLERS IN THE BASIS OF TIME-OPTIMAL CONTROL THEORY. Aleksakov, G. N.; Belousov, V. I.; Kryukov, A. P. At. Energ. (USSR); 32: No. 3, 228-9(Mar 1972). (In Russian).

Methods of perfecting reactor control systems based on the theory of fast-acting optimum control were studied. A mathematical model which describes reactor kinetics and servodrive dynamics is presented. The development sought to find limitations on the amount of control for which an absolute minimum functional is achieved, and a control law with reverse coupling which corresponded to the minimum functional. Calculated and actual power level changes are graphically compared for optimum control of the reactor IRT-2000. (K.S.W.)

30424 OPERATIONAL CHARACTERISTICS OF IONIZATION FISSION CHAMBERS FOR REACTOR CONTROL SYSTEMS. Dmitriev, A. B.; Malyshev, E. K.; Belozerov, V. G.; Shchetinin, O. I. At. Energ. (USSR); 32: No. 3, 230-1(Mar 1972). (In Russian).

Reactor control over 4–5 decades of power may be accomplished using an impulse ionization fission chamber or a current chamber. Two types of impulse ionization fission chambers whose sensitivities to thermal neutrons were about 0.25 to 0.5×10^{-4} impulse/neutron/cm^2 were studied under reactor conditions. The noise background was periodically measured. The collected integral current remained 10^{18} neutrons/cm^2 to the end of the test, and the increase in noise level was insignificant. The counting characteristics of the chambers were compared at the temperatures 20 to 400°, 500°, and 600°C. (K.S.W.)

30425 RAPID SHUTDOWN COUPLING DEVICES FOR NUCLEAR REACTORS. (to Siemens Aktiengesellschaft). British Patent 1,264,455. 23 Feb 1972. Priority date 19 Jun 1968, Germany.

REACTOR CONTROL ELEMENTS— drives for, shutdown coupling device for connection to (H.D.R.)

30426 INVESTIGATIONS ON THE BURN-UP OF BURNABLE POISON RODS CONTAINING Cd. Ahlf, J.; Kolb, M.; Krueger, A.; Lobmeyr, M.; Mueller, A. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Atomkernenergie; 19: No. 2, 101-6(Apr 1972). (In German).

In order to test the codes used at Geesthacht to calculate the burn-up of burnable poison rods, two Cd–Mg rods (1 cm diam. × 20 cm) were irradiated stepwise in a mean thermal neutron flux density of 5 to 6×10^{13} cm^{-2} s^{-1} until complete burn-up of ^{113}Cd. The neutron fluence for the irradiation steps was found by means of Co–Al activation wires. The reactivity reached by each rod was obtained within a small water-moderated subcritical assembly. The burn-up process measured in this way coincides with the calculated one which shows a distinct difference between "surface burn-up" for the high Cd density rod (70.4 weight percent Cd) and the "volume burn-up" of the lower Cd density rod (33.3 weight percent Cd.). (12 references) (auth)

30427 FUEL ASSEMBLY FOR NUCLEAR REACTOR. Arlaud, Jean Claude (to Commissariat a l'Energie Atomique). British Patent 1,262,839. 9 Feb 1972. Priority date 27 Jan 1970, France.

FILTERS— design of reactor coolant channel, for end connectors of liquid metal cooled fuel elements

REACTOR FUEL ELEMENTS— end connector for liquid metal cooled, filter assembly for

REACTORS, LIQUID METAL COOLED— fuel elements for, filter assembly for end connector of (H.D.R.)

30428 DESIGN OF FUEL ELEMENTS. Pickman, D. O. (United Kingdom Atomic Energy Authority, Preston, Eng.). pp 289-320 of Advanced Course on Limiting Aspects of Fuel Element Performance in Water Cooled Power Reactors. Kjeller, Norway; Institutt for Atomenergi (1971).

The design of rod bundle type fuel assemblies with UO_2 pellet fuel and Zircaloy cladding is discussed. In can design the problems of collapse behavior, ratchetting and wrinkling are treated, as are loss of thickness by corrosion, crud deposition, and hydrogen pickup. The use of annealed as compared with cold worked and stress relieved cladding is also treated and pickling and autoclaving are discussed. Fuel/can clearance is important in minimizing clad strain and ratchetting, and figures for allowable clad strain are suggested. The accepted design of fuel pellets is explained for considerations of thermal expansion and fuel swelling is discussed. The effects of H_2 and F impurities in the fuel are briefly mentioned. Spacer grid designs for various fuel assembly types are described and the effects of power cycling on fuel integrity are discussed. (Norway)

30429 FUEL ASSEMBLIES FOR NUCLEAR REACTORS. Cayol, Andre; Chalony, Andre; Clottes, Georges; (and others) (to Commissariat a l'Energie Atomique). British Patent 1,264,090. 16 Feb 1972. Priority date 12 Dec 1969; 20 Nov 1970, France.

REACTOR FUEL ELEMENTS— design of liquid metal cooled, with spacer means for equilization of coolant temperature at sub-channel outlets

REACTORS, LIQUID METAL COOLED— fuel elements for, equilization of coolant temperature at sub-channel outlets of (H.D.R.)

30430 REFUELLING MEANS FOR NUCLEAR REACTORS. Barker, Allan (to United Kingdom Atomic Energy Authority). U. S. Patent 3,635,792. 18 Jan 1972. Priority date 16 Aug 1967, Great Britain.

A fast reactor of the type which has its core submerged in a pool of liquid coolant contained in a vessel is provided with an annular store for fuel elements, the store also being submerged in said pool of liquid coolant and being disposed concentrically relative to said reactor core. Fuel-handling means are provided for moving fuel elements to said store and from thence to said core, and vice versa. The annular store is preferably rotatable relative to a fixed part of the reactor installation and enables unloading and loading of said store to be undertaken while the reactor is operating. The fast reactor is conveniently liquid-metal-cooled. (Official Gazette)

30431 SPACER GRID RESPECTIVELY PLATE SPRING FOR A BUNCH OF CYLINDRICAL ELEMENTS TAKING PART IN A HEAT-EXCHANGING PROCESS. Piepers, Gijsbrect G.; Vons, Leonard H.; Van Der Linde, Aart; Lijbrink, Edvard (to Reactor Centrum Nederland). U. S. Patent 3,646,994. 7 Mar 1972. Filed 23 Dec 1969.

A spacer grid is described for laterally displacing a plurality of nuclear reactor fuel rods. The fuel rods are in side-by-side parallel compartments, each compartment being provided with a specially shaped arched spring plate which engages the fuel element or heat exchanger tube. The spring plates are so contoured and apertured as to provide passages for the flow of heat exchange fluid to thereby avoid stagnation of the fluid. (auth)

30432 THEORETICAL AND EXPERIMENTAL ANALYSIS FOR OUT-OF-PILE SIMULATION OF IN-PILE THERMAL GRADIENT. Cesaroni, C. (Comitato Nazionale per L'Energie Nucleare, Casaccia, Italy. Rev. Int. Hautes Temp. Refract.; 8: No. 3-4, 185-96(Jul 1971).

Induction heating was used to simulate the parabolic temperature distribution of a fuel rod in the framework of thermal and mechanical studies of in-pile fuel behavior. The problem of the radial temperature distribution corresponding to the maximum temperature zone of a UO_2 pellet was studied. The effect of various parameters on the temperature distribution was examined. An analog method was developed, taking into account the nonlinear aspect of the problem, which allowed a parametric study based on the assumption of stationary conditions to be made. Experimental tests confirming the results obtained are presented. (France)

30433 PRESSURIZED FUEL ELEMENT. Ferrari, Harry M. (to Westinghouse Electric Corp.). U. S. Patent 3,644,174. 22 Feb 1972. Filed 19 Jun 1968.

A metallic clad sealed fuel element for a nuclear reactor is internally pressurized to resist creep collapse in the early stage of burnup. The fuel element has a normally sealed plenum chamber which is rupturable when a predetermined increased pressure is reached during burnup to provide a void space for fission gases. (Official Gazette)

30434 NUCLEAR REACTOR FUEL ELEMENT SPACER. Lass, James L.; Ross, Wilfred T.; Venier, Dominic A. (to General Electric Co.). U. S. Patent 3,654,077. 4 Apr 1972. Filed 17 Feb 1969.

A spacer is described for resiliently retaining the elongated fuel rods of a nuclear reactor in spaced relation. The spacer comprises a peripheral support band and dividers therein forming an "egg-crate" configuration of fuel rod passages. A spring member extends into each fuel rod passage from a corner. The spacer is designed to minimize the contact area of the fuel rod with the spacer, to minimize distortion and restriction of coolant flow and to minimize the amount of spacer and retainer spring material. One embodiment is especially designed for fabrication from low neutron absorption material, such as zirconium alloys. (auth)

30435 FUEL ASSEMBLY FOR A NUCLEAR REACTOR. (to Westinghouse Electric Corp.). British Patent 1,267,615. 22 Mar 1972. Priority date 29 Apr 1969, United States.

REACTOR FUEL ELEMENTS—design with provision for variations in thermal expansion of cladding and canning materials (H.D.R.)

30436 SYSTEM FOR DETERMINING LEAKAGE INSIDE A REACTOR CONTAINMENT. Campbell, Donald A. (to Westinghouse Electric Corp.). U. S. Patent 3,644,172. 22 Feb 1972. Filed 23 Sep 1968.

The invention provides a system for determining the total leakage of steam and water systems inside a reactor containment by measuring the condensate collected by the containment cooling coils. The leakage from the system is present in the containment as vapor, either directly or by subsequent evaporation from the liquid state, is transported by air circulated within the containment and removed by condensation at the cooling coils of the air recirculation system. As equilibrium normally exists between vapor addition to and removal from the air of the containment, measurement of the collected condensate provides measurement of leakage within the containment. (Official Gazette)

30437 FIZIKO-TEKHNICHESKIE OSNOVY PRIMENENIYA DISSOTSIIRUYUSHCHIKH GAZOV KAK TEPLONOSITELEI I RABOCHIKH TEL ATOMNYKH ELEKTROSTANTSII. (Physico-Technical Bases for Utilizing Dissociating Gases as Coolants and Working Substances in Atomic Power Stations). Nesterenko, V. B. Minsk; Izdatel'stvo Nauka i Tekhnika (1971). 312p.

The uses of dissociating gases as working substances in turbines and as coolants in nuclear reactors are examined. Dissociating systems in gas, gas-liquid, simple and binary cycles offer the possibility of raising the thermodynamic efficiency of atomic power plants. The physical and thermochemical properties of dissociating gases (N_2O_4, Al_2Cl_6, Al_2Br_6, etc.) could be exploited so as to increase turbine power and decrease their size as compared with water-steam. The corrosion properties of materials of construction in the working medium N_2O_4 are outlined. Thermodynamic cycles using dissociating heat exchangers are explored. (289 references) (tr-auth)

30438 MODEL FOR THE HIGH TEMPERATURE SWELLING OF CLAD OXIDE FUEL. Bauer, Arthur A. (Battelle Memorial Inst., Columbus, Ohio). Nucl. Technol.; 14: No. 1, 65-70(Apr 1972).

A fuel-specimen model was developed to describe the diametral swelling behavior of W–Re clad, oxide fuel specimens irradiated at clad surface temperature in excess of 1200 C. The model is based on experimental observations at elevated fuel temperatures that fission-gas bubbles form to expand the fuel but that bubble and lenticular void movement, as a result of vapor-phase transport, provide a mechanism for redensifying the fuel so that swelling is a continuous, steady-state process. Good agreement with experimentally measured diametral changes is obtained by application of the model. 9 references. (auth)

Reactor Physics and Core Engineering

Physics

Refer also to abstract 29473.

30439 (ANCR–1054) VIEWPIN: A FORTRAN PROGRAM TO CALCULATE VIEW FACTORS FOR CYLINDRICAL PINS. Singer, G. L. (Aerojet Nuclear Co., Idaho Falls, Idaho). Mar 1972. Contract AT(10-1)-1375. 71p. Dep. NTIS.

VIEWPIN is a computer code which calculates view factors (the fraction of the total radiation emitted from a source surface that strikes a target surface) for circular pins. View factors are necessary input to such radiation heat transfer codes as RADHT and MOXY. VIEWPIN is a two-dimensional code and assumes that the length of the circular pins is large compared to their diameters. The code can calculate a view factor within an array of pins to 0.01% accuracy in less than 0.25 second. The code provides for renormalizing the view factors to ensure that the sum of the view factors from one pin to all other pins in an enclosing array is unity. (3 references) (auth)

30440 (EIR–210) RADIAL DIFFUSION COEFFICIENTS FOR SQUARE LATTICES. Auerbach, T.; Haelg, W.; Mennig, J. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Feb 1972. 71p. Dep. NTIS (U. S. Sales Only).

The radial diffusion coefficient in a homogenized lattice is defined in accordance with the requirement of preserving leakage in passing from the actual, heterogeneous system to the homogenized one. Using this definition together with the heterogeneous flux in a finite square lattice in dipole approximation a closed buckling-dependent expression is derived for the radial diffusion coefficient with cell-edge normalization. Integration constants appearing in this formula are determined from a characteristic equation involving response coefficients. It is shown that the radial diffusion coefficient is given consistently only to order zero in the buckling. The corresponding buckling-independent equations for the diffusion coefficient are obtained from the buckling-dependent ones by consistent approximation. It turns out that the buckling-dependence cannot be removed if the core

size is of the same order as the diffusion length in pure moderator. Results of the theory are compared with other theories and a numerical example is given. (23 references) (auth)

30441 (JAERI-M-4544) SINGLE-CHANNEL SPACE-DEPENDENT REACTOR KINETICS CODE. Kambayashi, Yuichiro (Japan Atomic Energy Research Inst., Tokyo). Aug 1971. 40p. (In Japanese). NTIS (U. S. Sales Only).

The reactor power is intimately related with the thermohydraulic condition through the so-called feedback effect which is caused by the change of fuel temperature, fuel density, coolant temperature, coolant density, etc. Therefore, concerning the kinetics, it is essential to estimate the feedback effect exactly. RANRAN, a Single-Channel Space-Dependent Reactor Kinetics Code, is presented. In the code the power change is analyzed by use of the point approximation, while the space dependence can be taken into consideration for the estimation of feedback reactivity. The code serves to investigate especially the feedback effect due to the deformation of fuel temperature profile in the power transitional stage. (auth)

30442 (JAERI-M-4559) EXPERIMENTAL STUDIES ON THE CHARACTERISTIC VALUES OF A REACTOR COMPOSITION IN FAST SYSTEMS. Nakano, Masafum (Japan Atomic Energy Research Inst., Tokyo). Aug 1971. 53p. (In Japanese). NTIS (U. S. Sales Only).

Measurements of the characteristic parameters of a reactor composition are very important for fast reactor systems not only to know the characteristics of a composition but also to evaluate the cross sections used for reactor calculations. A method for the experimental determination of k_m^+, a characteristic value of a reactor composition, is proposed by using the reactivity worth of the central cell. The quantity k_m^+ may be regarded as a kind of infinite multiplication factor defined in the fundamental mode spectra which are independent of spatial problems such as the shape and the boundary of the medium, and therefore accurate calculation methods are available for k_m^+. The experimental result on the Fast Critical Assembly (FCA) shows that this method provides one of the useful data in the evaluation of the cross section library used for reactor calculations. From this principle, a new method of analysis is also derived for measuring the infinite multiplication factor, k_∞, in a test zone with a composition for which the value of k_∞ is nearly unity. The new method was applied for the k_∞ experiments carried out in FCA and compared with usual one. This method gives the theoretical basis for k_∞ experiments on fast reactor systems and also permits rather simple calculations. From the experiments, it was also confirmed that the experimental value of k_m^+ for typical large fast cores could be obtained within ± 0.01 on the zoned system which had a central test zone larger than fifteen times of the mean free path. (auth)

30443 (JPRS-55582 (pp 1-22)) DYNAMIC CHARACTERISTICS WITH OSCILLATIONS IN FUEL DENSITY. Blinkin, V. L.; Novikov, V. M. (Institut Atomnoi Energii, Moscow (USSR)). Translation of report IAE-2139. NTIS.

The dynamic reactivity of gas fueled cavity core reactors with external moderators are investigated. Equations are derived for calculating the effects of fuel density oscillations on dynamic characteristics. (H.D.R.)

30444 (JPRS-55582 (pp 23-50)) DYNAMIC REACTIVITY AS A FUNCTION OF SYSTEM PARAMETERS. Blinkin, V. L.; Novikov, V. M. (Institut Atomnoi Energii, Moscow (USSR)). Translation of report IAE-2140. NTIS.

The effects of fluctuations in fuel density, moderator parameters, and systems geometry on reactivity of gas fueled cavity core reactors with external moderators are investigated. (H.D.R.)

30445 (LA-4600) THEORY AND USE OF THE SPHERICAL HARMONICS, FIRST COLLISION SOURCE, AND VARIABLE WEIGHT VERSIONS OF THE TWOTRAN TRANSPORT PROGRAM. Lathrop, K. D.; Brinkley, F. W.; Rood, P. (Los Alamos Scientific Lab., N. Mex.). Mar 1972. Contract W-7405-eng-36. 27p. Dep. NTIS.

Described are three new versions of the TWOTRAN program for solution of the multigroup discrete ordinates approximation to the two-dimensional Boltzmann transport equation. The first of these versions, TWOTRAN PN, is designed to solve discrete ordinates equations that have been converted to equations like spherical harmonics equations to eliminate ray effects. The second version, TWOTRAN FC, computes the analytic flux due to a point source on the axis of a finite cylinder and automatically uses this flux to compute the first collision source of particles for further transport. The third version, TWOTRAN VW, uses a variable weight diamond difference scheme for calculating spatial derivatives. All three versions operate from the basic TWOTRAN program and offer the options available in that program for three two-dimensional geometries. Typical results of applying each of the versions of TWOTRAN are given. 15 references. (auth)

30446 (LA-4750) LAPHANO: A P_0 MULTIGROUP PHOTON-PRODUCTION MATRIX AND SOURCE CODE FOR ENDF. Dudziak, D. J.; Seamon, R. E.; Susco, D. V. (Los Alamos Scientific Lab., N. Mex.). Jan 1972. Contract W-7405-eng-36. 12p. (ENDF-156). Dep. NTIS.

The LAPHANO code is a revision of the LAPH code and is intended to be an interim P_0 version of a more general P_4 code, LAPHAN. Photon-production cross-section data are retrieved from the ENDF Files 12 through 15, processed into specified photon and neutron energy groups, and combined as necessary to produce photon-production matrices. These can be either microscopic or macroscopic matrices for mixtures of materials. Also, spatially dependent photon-production source vectors can optionally be calculated from the macroscopic matrices. Production cross sections are averaged over neutron fine groups and then collapsed into a given broad-group structure using input weighting functions. Multiple zones can be accommodated with separate weighting functions for each zone. A code package including the FORTRAN-IV source deck, a sample problem input and output, and an INDEX (cross reference) listing are available from the Radiation Shielding Information Center at the Oak Ridge National Laboratory. The code is presently operational on CDC 6600, CDC 7600, IBM 360, and UNIVAC 1108 computers. 6 references. (auth)

30447 (UJV-2705-R) HETEROGENEOUS LOCALIZED REACTOR CALCULATION IN A TWO-GROUP APPROXIMATION (MATTHAEUS PROGRAM). Lelek, V. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1971. 32p. (In Russian). Dep. NTIS (U. S. Sales Only).

A complete description of an Algol program and the basic formulas for heterogeneous localized reactor calculations are given. It is proposed that a rod be characterized by a thermal neutron absorption γ, fast neutron absorption ω, and a transition of fast neutrons to thermal σ. The moderation process is described by two-group equations. Inside the reactor there is assumed a bundle of rods within a circle of a given radius, and for which the general heterogeneous equations are formulated. The remainder of the reactor, being outside of the given circle, is described by fictitious sources, and to which a certain power is assigned in order that the equations will have real solutions. (tr-auth)

30448 HYBRID METHOD FOR SOLVING THE REACTOR SPACE-TIME-DEPENDENT EQUATIONS. Saphier, D. (Soreq Nuclear Research Centre, Yavne, Israel). Nucl. Sci. Eng.; 47: No. 3, 275-89(Mar 1972).

A new hybrid method was developed for the solution of the one-dimensional time-dependent diffusion equation in four energy and four delayed-neutron groups. Using this method it is possible to reduce the cost per problem solved by an order of magnitude compared with commonly used digital methods. The solution is based on discretizing the multigroup diffusion equation with respect to the spatial variable while leaving the time variable continuous. The simple coupled time-dependent differential equations so obtained are integrated continuously and in parallel for each of the reactor regions. The regional boundary values are updated from iteration to iteration until convergence is obtained. Two examples are presented in which the hybrid and digital solutions are compared for a fast plutonium oxide fueled reactor. The agreement between the hybrid and digital solution is fairly good. 27 references. (auth)

30449 APPLICATION OF THE FINITE ELEMENT METHOD TO THE MULTIGROUP NEUTRON DIFFUSION EQUATION. Semenza, L. A.; Lewis, E. E.; Rossow, E. C. (Northwestern Univ., Evanston, Ill.). Nucl. Sci. Eng.; 47: No. 3, 302-10(Mar 1972).

The finite element method is applied to the multigroup neutron diffusion equations. The one-group inhomogeneous diffusion equation is first discretized using both triangular and rectangular elements. The finite element method is then extended to energy-dependent diffusion by treating the multigroup equations as a series of inhomogeneous one-group equations with sources arising from fission and group-to-group scattering. The resulting formalism is incorporated into a computer code for solving multigroup criticality problems by power-iteration techniques. Numerical results are presented for a two-group water reactor problem. Eigenvalues and flux distributions obtained from two finite element calculations using less than 500 simultaneous equations are in excellent agreement with an accurate PDQ calculation. 30 references. (auth)

30450 HETEROGENEOUS METHOD FOR CALCULATING LONG TERM REACTIVITY CHANGE IN A REACTOR INCLUDING BURNABLE POISON RODS. Hishida, Hisashi (Mitsubishi Atomic Power Industries, Inc., Omiya, Japan); Sekiya, Tamotsu. Nucl. Sci. Eng.; 47: No. 3, 319-28(Mar 1972).

A heterogeneous method of calculating time-dependent reactor core characteristics, such as the time variation in thermal-neutron flux distribution and the reactivity change during fuel and poison burnup, is derived. The lattice consists of an infinite number of similar square zones closely connected to one another. In each zone, identical fuel rods are arranged in a regular lattice with a burnable poison rod of the same geometric dimensions as a fuel rod at the center. Some numerical examples, utilizing the equations derived finally, give the time variation in poison concentration and $k_\infty(t)$ for a zone showing the heterogeneity effect associated with a burnable poison rod. Since the machine time required to compute the time variation of such core characteristics through fuel life of 11,000 EFPH as shown in the examples is <25 sec on the IBM 360/75 per case, the method may be applied to the preliminary survey calculation for the time-dependent heterogeneous core characteristics of a square lattice including burnable poison rods as well as to more general time-dependent problems related to such lattices. 9 references. (auth)

30451 PRINCIPLE OF INFORMATION FLOW FOR THE TREATMENT OF DISCONTINUITIES IN SYNTHESIS TECHNIQUES. Becker, Martin (Rensselaer Polytechnic Inst., Troy, N..Y.). Nucl. Sci. Eng.; 47: No. 3, 365-70(Mar 1972).

One of the difficulties associated with the use of discontinuous trial function methods is the tendency to obtain overdetermined interface conditions. A principle of information flow is set forth to guide the specification of interface conditions. The principle is based on dealing with variables that transmit information separately in each direction at an interface and on weighting a discontinuity at an interface according to the importance of the information in the region to which it is being transmitted. The asymmetric discontinuity treatment of initial-value problems follows from the principle. Treatment of boundary-value problems is illustrated by a partial-current formulation of diffusion theory. The proper number of interface conditions is obtained even for the case of different numbers of trial functions in different spatial regions. 13 references. (auth)

30452 ADDENDUM TO NOTE ON SUBCRITICAL REACTIVITY FROM REACTOR NOISE. El-Zeftawy, Medhat M.; Ruby, Lawrence (Univ. of California, Berkeley). Nucl. Sci. Eng.; 47: No. 3, 370-1(Mar 1972).

In an earlier communication the measurement of subcritical reactivity utilizing reactor noise where all delayed neutrons were lumped into a single equivalent group was discussed. The analysis was refined in a manner to include all delayed-neutron groups and a different relation exists between subcritical reactivity and experimentally measurable quantities. (auth)

30453 SMALL-SAMPLE DOPPLER EFFECT MEASUREMENTS AND THEIR INTERPRETATION IN FAST REACTOR SPECTRA. Barleon, L.; Fischer, E. A. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Sci. Eng.; 47: No. 3, 247-61 (Mar 1972).

The pile oscillator technique was used to measure the Doppler effect with heated small samples in neutron spectra typical of steam cooled fast reactors. Samples of UO_2 in various enrichments, especially depleted UO_2, were measured up to 1000°K, and also samples of PuO_2, diluted with Al_2O_3. The results were analyzed by a method which properly accounts for the resonance interaction between the hot sample and the cold environment. The results with the UO_2 samples where ^{238}U gives the major contribution to the Doppler effect were in agreement with calculations within about 10%, though changes of the effect between different assemblies, in some cases, were not well reproduced. The experiments with PuO_2 samples were designed to give integral information on alpha of ^{239}Pu in the range 0.1 to 5 keV. It is shown that experiment and calculation agree within about 25% if high alpha values similar to those of Gwin are used. 27 references. (auth)

30454 FORMULATION AND APPLICATION OF THE TRANSFER-SCATTERING MATRIX METHOD TO SPACE-, ENERGY-, AND ANGULAR-DEPENDENT FAST REACTOR KINETICS. Dodds, H. L. Jr. (Univ. of Tennessee, Knoxville); Robinson, J. C.; Buhl, A. R. Nucl. Sci. Eng.; 47: No. 3, 262-74(Mar 1972).

A transfer and scattering matrix technique is used to solve one-dimensional, time-dependent, multigroup, discrete ordinates equations and those including the delayed-neutron equations. The solution is obtained in the frequency domain as a distributed parameter transfer function. This technique can accomodate anisotropic, spatially distributed extraneous sources and general anisotropic scattering. The numerical problems associated with the technique are analyzed, and a procedure is presented for controlling them. The results obtained with this technique are in good agreement with (a) statics results obtained from standard discrete ordinates calculations, and (b) experimental kinetics noise data obtained from a critical fast assembly. Calculated results of a simulated pulsed-neutron experiment on a subcritical fast assembly are presented. 19 references. (auth)

30455 SMALL-GROUP NEUTRON MODERATOR MODEL FOR WATER-ALUMINUM REACTOR CORE CALCULATIONS. Garusov, E. A.; Petrov, Yu. V. At. Energ. (USSR); 32: No. 3, 225-7(Mar 1972). (In Russian).

A small-group diffusion model is the simplest theoretical model for reactor calculations which is at the same time sufficiently accurate for neutron moderation. A comparison is made of the algebraic relations resulting from the use of n-group, two-group, single-group neutron-moderation diffusion models, age theory, and a non-diffusion model ("straight flight"). (12 references) (K.S.W.)

30456 METHOD OF TREATING REGULAR NEUTRON ABSORPTION SYSTEMS. Shevelev, Ya. V.; Chikhladze, I. L. At. Energ. (USSR); 32: No. 1, 27-32(Jan 1972). (In Russian).

A new method of treating reactor regular absorbtion systems is proposed. It is based on using average neutron fluxes obtained by integration of general solutions over the lattice pitch. Boundary conditions for these fluxes are received which are to be used instead of ordinary continuity equations. The boundary conditions established take into consideration specific absorber properties as well as absorber displacement. The method proposed has the advantage of avoiding the coupling of the description of the reactor geometry with that of the reactor absorbers. This results in facilitating the solution of the criticality problem and if necessary, the real neutron distribution for rather complex systems. (auth)

30457 BASIC RESEARCH OF REACTOR KINETICS BY ANALYTICAL METHOD. Amano, Fumio (Electrotechnical Lab., Tokyo). Denshi Gijutsu Sogo Kenkyusho Kenkyu Hokoku; No. 714, 1-122(Mar 1971). (In Japanese).

Theories and techniques were developed in order to analyze some basic problems regarding physics equations for reactor kinetics. These problems are one point kinetics of bare reactors, space-dependent kinetics regarding reactivity analysis in a multi-domain reactor by pulsed neutron source methods, and analysis of the control rod effect by the pulsed neutron source method. The new theories contain the following characteristics: (1) The one point kinetics equations are transformed into a singular pertrubation problem and resolved by MAE method. (2) Noticing that ω_p mode by prompt neutrons has no interference mutually, a new expansion method is developed, which produces different eigenfunction series in each domain. (3) For analyzing reactivity effects by kinetic distortion, generalized inhour equations are produced, which combine static reactivity with a prompt neutron decay constant and kinetic flux. (4) Using the prompt neutron decay constant and an effective multiple coefficient, the control rod effect is analyzed, when control rods are inserted at arbitrary depth. Many numerical experiments carried out with computers and experiments in a semi-homogeneous critical assembly in JAERI showed the propriety of the new theories. (Japan)

30458 DEVELOPMENTS IN PRACTICAL TIME SERIES ANALYSIS METHODS IN THE PHYSICAL SCIENCES. Kemeny, Leslie G. (Univ. of New South Wales, Kensington, Australia). J. Nucl. Sci. Technol. (Tokyo); 9: No. 2, 119-23(Feb 1972).

Digital, high speed, time series analyzers in use at the University of New South Wales are described. Applications of the equipment in the analysis of reactor physics parameters are discussed. (H.D.R.)

30459 POWER SPECTRUM ESTIMATION OF LARGE STOCHASTIC TIME SERIES. Hoeld, A. (Technische Univ., Munich). Atomwirt. Atomtech.; 17: No. 4, 205-6(Apr 1972).

The BMDX92 computer program was modified to include statistical time series with unrestricted recording length. The new program, TUMX92, can be used in reactor noise analysis. (H.D.R.)

30460 HYBRID COMPUTATION OF SPACE AND ENERGY DEPENDENT NUCLEAR REACTOR KINETICS. Schultz, Kenneth R. Gainesville, Fla.; Univ. of Florida (1971). 186p. University Microfilms Order No. 72-9719.

Thesis.

A method of direct numerical solution of the time, space, and energy dependent neutron diffusion equation was developed that utilizes the unique capabilities of the hybrid computer. The hybrid method uses an iterative discrete space—continuous time algorithm. The space derivatives of the conventional multigroup reactor kinetics equations are represented by finite difference approximations. The resulting very large set of coupled ordinary differential equations in time can be solved quite readily on the hybrid computer by multiplexing the analog hardware and using an iterative procedure. The flux, precursor, and temperature equations at one space point are set up on the analog computer. The digital computer supplies the space coupling terms from adjacent space points; it also observes and stores the solutions for later playback. Feedback effects are calculated by the digital machine and are implemented by means of variable coefficients. Automatic digital rescaling of the analog equations allows consideration of realistic reactor dynamics studies involving flux level changes of many orders of magnitude. The hybrid method is well suited for solution of the space and energy dependent reactor kinetics equations and shows strong potential for use in nuclear reactor engineering design. It offers reasonable accuracy at modest cost. Hybrid solutions to typical spatial kinetics examples and a description of the HYKIN 3 hybrid kinetics code, which is functionally equivalent to the WIGL 2 digital program, are presented. (Diss. Abstr. Int., B.)

30461 LOCAL POWER MEASUREMENTS USING GAMMA RAY FLUCTUATIONS. LeVert, Francis Edward. University Park, Pa.; Pennsylvania State Univ. (1971). 107p. University Microfilms Order No. 72-9498.

Thesis.

Local measurements of the inherent fluctuations in the gamma ray source strength at specific core locations were conducted using two externally located detectors. Two liquid scintillators coupled to two phototubes were used to monitor high energy gamma rays originating in neutron capture events and fission reactions. Both detection systems were designed to pass a well collimated beam of high energy photons. Local power level was defined for positions up to the center of the core by measuring the zero-time cross correlation function in small intervals. Voids introduced by the removal of single fuel elements were readily located and mapped. Single collimator observations were carried out to measure the integrated local power along a line through the core. Single collimator scans along the diagonal rows in the core were successful in resolving the separate rows of fuel in the core. A comparison between the neutron distribution predicted by two dimensional multi-group diffusion theory and a single collimator measurement showed very good agreement. Using the raw data of the zero-time-delay correlation measurements, which were recorded on magnetic tape during these observations, analog and digital calculations were performed in the frequency domain. Co-power spectral densities were obtained for the cases when the collimators focused on and off a volume of fuel in the core. The off fuel spectra had a break point near one Hz with a constant rate of roll-off beyond one Hz. The on-fuel spectra possessed definite energy content up to higher frequencies of approximately 13 Hz. These spectra were then fitted to an analytical model developed for the experiment. The frequency data indicated, when interpreted in terms of the model, that the observed output fluctuations were caused by input temperature and coolant flow fluctuations. (Diss. Abstr. Int., B)

30462 PARAMETER IDENTIFICATION IN NUCLEAR REACTOR SYSTEMS. Roman, William Stanley. Charlottesville, Va.; Univ. of Virginia (1971). 233p. University Microfilms Order No. 72-7145.

Thesis.

Several techniques are developed for the identification of unknown parameters in lumped and distributive parameter models of nuclear reactor systems. Specifically a set of algorithms are developed for updating initial parameter estimates by minimizing a least squares criterion function using simulated measurements of the system variables. For the lumped parameter system, the quasilinearization technique is shown to be an effective method of identifying parameters in a spatial dependent nonlinear model of a liquid metal fast breeder reactor (LMFBR). Identification of up to four feedback temperature coefficients in one and two neutron energy group models is shown to yield excellent results. In addition to demonstrating the applicability of the quasilinearization technique to nuclear reactor models, studies were made to illustrate the effect of initial parameter estimates, measurement errors, and number of measurements upon the accuracy of the identification. Also several modifications are made to the criterion function to increase the accuracy of the identification. To identify parameters in a distributive parameter system, a set of quasi-Newton gradient techniques are shown to be effective methods for parameter identification. The gradient techniques that were analyzed are the Gauss-Newton, conjugate gradient, and variable metric. Results of the analysis showed that the Gauss-Newton technique was superior to the other methods in both accuracy and efficiency. These results were obtained for a time dependent extension of the nonlinear LMFBR model analyzed for the lumped parameter system, and two linear models of heat transfer and fluid flow processes that are encountered in the analysis of nuclear reactor systems. Results for both the lumped and distributive parameter models illustrated the accuracy and the numerical efficiency of the algorithms that were developed for determining unknown parameters. (Diss. Abstr. Int., B)

30463 RESPONSE OF A LARGE NUCLEAR REACTOR TO AN OSCILLATING SOURCE PERTURBATION. Olson, Robert Linwood. Knoxville, Tenn.; Univ. of Tennessee (1971). 159p. University Microfilms Order No. 72-5470.

Thesis.

Spatial effects on the response of a large nuclear reactor to a source oscillation and the effects of a reflector on the response of a nuclear reactor to a source oscillation were investigated. These objectives were accomplished by observing the output signals of neutron detectors in a large cylindrical nuclear reactor with an oscillating fast-neutron source. The oscillating source was placed at the vertical midplane of the reactor at several horizontal locations, and the neutron detectors were placed along an axially-centered diameter of the reactor. Data were taken for both reflected and non-reflected radial boundary conditions for oscillation frequencies from one-tenth Hertz to sixty Hertz. Reference signals produced by a sinecosine generator coupled to the oscillator were used to electronically Fourier-analyze the neutron detector output signals. The reactor response was found to exhibit large deviations from that predicted by the space-independent model. The reactor response predicted by a time-dependent diffusion theory computer code agreed well with the experimental data for those cases in which the code was an accurate model. The existence of propagating macroscopic neutron waves was confirmed. (Diss. Abstr. Int., B)

30464 CONTROL OF QUASISTATIC DISTRIBUTED PARAMETER SYSTEMS WITH APPLICATION TO REACTOR THEORY. Surendran, Kamayasamy. Stony Brook, N. Y.; State Univ. of New York (1971). 84p. University Microfilms Order No. 72-6397.

Thesis.

Control of quasistatic distributed parameter systems is studied. In particular, non-dimensionalized diffusive systems with a large coefficient of diffusivity, whose reciprocal is a small parameter, are treated for optimal control, either from the boundary or through a source placed inside the medium. Singular perturbation techniques and calculus of variations are the main tools employed to achieve a control procedure consisting of two iterative schemes, one each for spatial and time factors. Three types of integral criteria are considered and in each case the deviation of flux around a desired distribution is minimized for a given response time. Further, in each case slowly changing control functions are obtained for the above type of system, in which the control is felt immediately and the effect is transmitted rather quickly compared to the time behavior of control itself. The different controls are established mainly on the basis of the outer expansion alone. However, methods based on initial layer expansion are suggested to correct the above control. The procedure is applied to control the xenon oscillations, found in large thermal nuclear reactors. The linearized kinetic equations which depict the xenon phenomenon along with temperature effects are first identified to be a quasistatic diffusive system and then suitable manipulations are made on them to make direct use of the two iterative schemes for obtaining the control. (Diss. Abstr. Int., B)

30465 NEUTRON FLUX MEASUREMENTS USING THIN FILMS OF ENRICHED URANIUM DIOXIDE. Feintuch, Karl David. Charlottesville, Va.; Univ. of Virginia (1971). 172p. University Microfilms Order No. 72-7221.

Thesis.

A highly enriched, water moderated, slab geometry core was mapped to give the fast and thermal activities in the core and reflector. The maps were made using bare and cadmium covered fission films of enriched uranium dioxide. The maps were accurate in magnitude as well as shape because the thin films did not require corrections for self-shielding. The films were prepared by vapor deposition of uranium dioxide onto an aluminum backing. The deposits were 500 to 1500 angstroms thick.

The natural alpha activity of the ^{234}U isotope present was used to calibrate the films to within 3% uncertainty. An experiment was performed to confirm the absence of self shielding. For convenience the fission rate was represented by the area under a fission product gamma decay rate curve. The uncertainty for the experiment was predominately due to the contribution from the thickness determination. Therefore, all data points had approximately a 3% uncertainty. The flux maps generated from the slab geometry core were compared to the predictions of diffusion theory. The diffusion theory code used (FOG) was a one dimensional calculation in which all constants were averaged over the entire core or reflector. Such a code can not take into account the spectrum changes that occur near an interface. Even so, the diffusion theory predictions were substantially improved by simply using a value of 48 barns for the hydrogen transport cross section in the thermal diffusion coefficients. The code predicted the experimental thermal flux within the accuracy of the experiment. Since the thermal group energy spectrum in the reflector would be expected to be somewhat softer than that in the fuel, part of the observed fission activity may be explained by changes in the fission cross section of the fission film; this could lead to a revised value of the hydrogen transport cross section in water lying between 33 and 48 barns. (Diss. Abstr. Int., B)

30466 COMPUTATION OF FINITE STABILITY REGIONS IN NUCLEAR POINT REACTOR DYNAMICS. Willems, Jacques L. (Harvard Univ., Cambridge, Mass.). pp 69-81 of XI International Automation and Instrumentation Conference. Vol. 1. Milan; Federazione delle Associazioni Scientifiche e Technische (1970).

From eleventh international automation and instrumentation conference; Milan, Italy (23 Nov 1970). See CONF-701145-(Vol. 1).

The construction of Lyapunov functions and the computations of finite stability regions for the point model of nuclear reactors without delayed neutrons are presented. It is shown that even in the cases for which the Popov criterion does not prove global stability, the criterion is useful for constructing Lyapunov functions. Two procedures are discussed; they are respectively derived from Brockett's integration-by-parts technique and from the Kalman–Yacubovich lemma. The stability regions are computed from the Lyapunov functions by means of the methods of the open and closed Lyapunov contours. Numerical examples illustrate the proposed procedures and show that considerable improvement of earlier results is obtained for some cases. (9 references) (auth)

30467 SOME CONSIDERATIONS ABOUT PARAMETER ESTIMATION IN NUCLEAR REACTORS FOR SAFETY TESTING PURPOSES. Lucia, A. C. (EURATOM, Ispra, Italy). pp 403-25 of XI International Automation and Instrumentation Conference. Vol. 1. Milan; Federazione delle Associazioni Scientifiche e Technische (1970).

From eleventh international automation and instrumentation conference; Milan, Italy (23 Nov 1970). See CONF-701145-(Vol. 1).

Some aspects of the problem of nuclear reactor identification by noise analysis techniques are described in order to examine and point out the possibilities and the applications of these techniques in the field of safety monitoring and testing. A brief analysis of the statistical properties of estimates of the power and cross-power spectral densities and of the auto and cross-correlation functions is carried out for the case of stationary random signals in neutron multiplying media. As far as experimental analysis is concerned, reference is made to a general purpose analyzer designed and built at the Euratom J.N.R.C. in Ispra. Results already obtained with the equipment are discussed. (44 references) (auth)

30468 RIGOROUS COLLAPSE PROCEDURE FOR MULTIGROUP NEUTRON CROSS SECTIONS. Doyas, Richard; Koponen, Brian (Univ. of California, Livermore). Nucl. Sci. Eng.; 47: No. 4, 472-5(Apr 1972).

A rigorous treatment of group collapse in a Legendre expansion of the neutron transport equations leads to significantly improved results from calculations with the collapsed cross sections. (auth)

30469 FORMULATIONS OF SPACE-ENERGY-TIME ITERATIVE SYNTHESIS. Fuller, E. L. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 47: No. 4, 483-8(Apr 1972).

A general formulation of space-energy-time iterative synthesis in neutron diffusion theory is developed. A description of the iterative synthesis procedure is presented, followed by applications to the steady-state and time-dependent diffusion equation. It is shown how spatially and/or temporally discontinuous shape functions can be included. Finally, application is made to the discontinuous energy (multigroup) diffusion theory model. 18 references. (auth)

30470 VARIATIONAL FLUX SYNTHESIS METHODS FOR MULTIGROUP NEUTRON DIFFUSION THEORY. Stacey, Weston M. Jr. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 47: No. 4, 449-69(Apr 1972).

A consistent codification and generalization of previous formalisms for extensions that result in new approximation methods are presented. The discussion is restricted to the multigroup neutron diffusion equations. The development of variational principles that admit discontinuous trial functions which need satisfy neither the final and initial conditions nor the external boundary conditions of the physical problem is reviewed and generalized. Consistent single-channel and multichannel spatial synthesis and spectral synthesis formalisms are developed. The difficulty with overdetermined interface conditions which has arisen in previous work is traced to a failure to properly apply continuity requirements at these interfaces so as to relate variations in the adjoint trial functions on opposite sides of the interface. A generalized nodal formalism is developed as an extension of the variational synthesis method. The use of a particular type of piecewise cubic polynomial to modulate expansion functions is introduced as a means to obtain overlapping multichannel synthesis and generalized nodal approximations which do not require the evaluation of troublesome surface integrals. A brief review of experience with variational synthesis methods for the multigroup neutron diffusion equations is given. 55 references. (auth)

30471 EWA-II: TWO-DIMENSIONAL TWO-GROUP DIFFUSION FAST CODE. Woznicki, Zb. (Inst. of Nuclear Research, Swierk, Poland). Kernenergie; 14: No. 10, 325-8(Oct 1971).

A two-dimensional two-group diffusion criticality for the GIER computer is described, its basic algorithm and the acceleration procedure are given. The accuracy of results and time requirements, depending on the number of mesh points, are compared with those of TWENTY GRAND for a test case reactor. (auth)

30472 VARIATIONAL ACCELERATION TECHNIQUE FOR THE ITERATIVE SOLUTION OF THE TWO-GROUP NEUTRON DIFFUSION EQUATIONS. Brusa, L.; Giorcelli, M. (CISE, Milan). Energ. Nucl. (Milan); 19: No. 4, 251-6(Apr 1972).

The static or dynamic two group neutron diffusion equations are usually solved by means of discretization techniques and the approximate solution is then obtained by solving a large linear system. At this aim, iterative methods can be used and, to have acceptable running times, the choice of a convenient scheme is an important item. A nonlinear iterative procedure described by Wachspress is considered. This method is based on a variational acceleration procedure which is periodically applied to an otherwise conventional linear iteration. Illustrative results are given. (auth)

30473 NEW INTERPRETATIONS FOR THE USACHEV–GANDINI PERTURBATION THEORY. Komata, Masaoki (Hitachi Ltd., Kawasaki, Japan). Nucl. Sci. Eng.; 47: No. 4, 489-93(Apr 1972).

The perturbation formula of Usachev–Gandini for a ratio of reaction rates is newly explained by (a) a formal functional treatment of perturbation theory and (b) the variational principle. At the outset a time-dependent problem is considered, and a perturbation formula of a reaction number ratio is obtained. In a static problem this formula directly turns to a formula of a reaction rate ratio which reduces to the Usachev–Gandini formula when an adiabatic approximation is introduced. It is shown that there is no need to solve iterative equations of successive neutron generations. 13 references. (auth)

Core Thermal Hydraulics

30474 (AECL-4070) FLUID MODELING OF CRITICAL HEAT FLUX IN UNIFORMLY HEATED ANNULI. Ahmad, S. Y.; Groeneveld, D. C. (Atomic Energy of Canada Ltd., Chalk River (Ontario), Chalk River Nuclear Labs.). Jan 1972. 14p. (CONF-710836-1). Dep. NTIS (U. S. Sales Only). AECL $0.50.

From International symposium on two-phase systems; Haifa, Israel (29 Aug 1971).

The results of an experimental and analytical program to develop Freon–water modeling of critical heat flux in annular geometries are presented. Experimental critical heat flux data were obtained with Freon-12 over a wide range of pressure and mass flux. These were compared with water data using Ahmad's compensated distortion model. A critical heat flux correlation for annular geometries which is independent of fluid types was de-

veloped from the Freon data and subsequently applied to published water data. It is concluded that adequate modeling of critical heat flux in an annular geometry can be obtained, provided the size of the model and prototype is identical. (15 references) (auth)

30475 (FRNC-CONF-22) NUMERICAL CALCULATIONS ON THE TRANSFER OF HEAT BY NATURAL CONVECTION IN A CAVITY. APPLICATION TO LIQUID METALS. Daubert, A.; Graffe, O.; Burg, M. C. (Electricite de France, Clamart). Mar 1971. 7p. (In French). (CONF-710939-3). Dep. NTIS (U. S. Sales Only).

From Conference on natural and mixed convection and its industrial application; Ermenonville, France (13 Sep 1971).

The liquid metals used as reactor coolants are characterized thermally by their low Prandtl number. A rectangular cavity whose walls are maintained at different temperatures is used as an example. Using the Navier–Stokes equations and the heat transfer, the natural laminar convection which develops is calculated; the horizontal walls are assumed to be adiabatic. Experimental formulas, already established, are used to determine the transfer laws for the fluids normally used. The calculations presented demonstrate to what extent these laws must be modified for the case of liquid metals. In parallel with this overall view of the phenomenon, detailed results on the velocities and temperatures in the fluid are presented. (France)

GENERAL

Civilian Defense

30476 (CTC–55) CTC'S INDEX PRINTING PROGRAM (CIPP). Brasher, Jennifer C. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). 11 Apr 1972. Contract W-7405-eng-26. 63p. Dep. NTIS.

CIPP (CTC's Index Printing Program) is a generalized index-formatting program; it is designed to produce printed indexes, bibliographies, or similar publications in various formats specified by the user at program execution time. The desired formats are defined with parameter statements which correspond to flags inserted in the input data. Several indexes, each in various formats, may be printed in one program run. Formatting functions handled by the program include page and column size, page numbering, finder words, duplicate checking, overstriking, and elimination of "widows" at the top of columns and pages. CIPP was written in PL/I for the IBM 360 computer with the IBM Operating System. (auth)

Law

30477 FRENCH REGULATIONS ON THE USE OF RADIOELEMENTS. Mayoux, J. C. (CEA, Paris). Bull. Droit Nucl.; No. 8, 55–61(Nov 1971). (In French).

The regulations and authorization concerning radioelements (trading, possession, and use) appear in the French regulations on Public Health. Natural radioelements are covered by the regulations for poisonous substances. Favorable decisions from the CIREA (Commission Interministerielle des Radioelements Artificiels) and the SCPRI (Service Central de la Protection contre les Rayonnements Ionisants), the latter being responsible for the verification of the analysis, doses, and installation monitoring, are necessary for possessing artificial radioelements. Special regulations apply to medical uses, and industrial uses. Industrial uses must comply with the classified establishment's regulations. (France)

30478 SURVEY ON ACTUAL CONDITIONS OF RADIATION PROTECTION AND OF PREVENTION FROM RADIATION INJURIES IN JAPAN. Nippon Hoshasen Gijutsu Gakkai Zasshi; 26: No. 4, 81-93(Mar 1971). (In Japanese).

The present state of radiation protection was investigated over a period of 3 yrs on 180 institutions, mainly hospitals, in four prefectures in Japan. Results obtained are as follows. Even at present, the number of radiologists is insufficient, and full-time doctors are present in only 33.9% of the institutions. In 65.6%, an administrative department is not yet established. Only 21.1% have their own dosimeters, and measurement of radiation dose rate was not performed in 47.8%. Radiation protection of facilities is reported to be in good condition in 87.8%. In almost all institutions, protection of workers and patients from radiation injuries is well carried out by the use of protectors and shielding. Blood examination of the workers is performed four times a year in 46.7%, two times in 26.5%. However in 5.6%, it is not performed. A record of health examinations is retained in 56.7%. For personal monitoring, film badges are utilized in 76.1%. Annual accumulated exposure dose does not exceed 5 R in any members investigated, and that of more than 60% of the members is below 500 mR. It is regrettable that there are some institutions in which personal monitoring is not performed throughout the year. Recently, institutions in which radioisotopes are utilized tend to increase, and also the number of technicians engaged in handling radioisotopes is increasing. More than 80% of the workers have not suffered from radiation injuries. Hematopoietic disturbance accounts for 60.5% of the radiation injuries. (Japan)

30479 DATA ACQUISITION AND REAL-TIME SYSTEMS. Proceedings of a Seminar Held at Canberra, Australia, 9 December 1970. Lawrence, D. E.; Fenwick, P. M. (eds.). St. Lucia, Australia; University of Queensland Press (1971). 170p. $2.50. (CONF-701225).

Thirteen papers dealing with data acquisition, programming problems and real time systems are presented. Four papers are given separate abstracts. (Australia)

For abstracts of individual papers see: 30480–30483.

30480 HARDWARE AND SOFTWARE FOR DATA ACQUISITION ON THE ANU IBM 1800. Hebbard, D. F. (Australian National Univ., Canberra). pp 13-23 of Data Acquisition and Real-Time Systems. Lawrence, D. E. (ed.). St. Lucia, Australia; Univ. of Queensland Press (1971).

From Seminar on data acquisition and real time systems, Canberra, Australia (9 Dec 1970).

A description is given of priority levels for nuclear physics tasks run on an IBM 1800 computer. Hardware consists of 32K 16-bit words, 2 μsec memory cycle, 12 interrupt levels, 9 data channels, an Add-One-To-Storage feature, 2 words of digital input, 1 word of process interrupt and 3 words of digital output. Software modifications have eliminated limitations inherent in the original form and now provide the necessary data protection and speed for nuclear physics data acquisition. A further improvement in speed has resulted from the construction of a small specialized "front-end" computer to remove much of the trivial raw data processing from the 1800 computer. (Australia)

30481 DATA ACQUISITION AND ON-LINE ANALYSIS ON AN HP2116B COMPUTER. Fenwick, P. M. (Univ. of Auckland, N. Z.). pp 42-53 of Data Acquisition and Real-Time Systems. /Lawrence, D. E. (ed.). St. Lucia, Australia; Univ. of Queensland Press (1971).

From Seminar on data acquisition and real time systems; Canberra, Australia (9 Dec 1970).

Programming methods which have been used for the acquisition and processing of nuclear data at Auckland University are discussed. The Hewlett–Packard 2116B and its peripheral devices are described in relation to their role in the collection and analysis of data. A keyboard monitor which has been developed to provide efficient and flexible control of data acquisition programs is described. (Australia)

30482 ACCESS TO PROGRAMS AND DATA ON THE ANU IBM 1800. Hay, H. J. (Australian National Univ., Canberra). pp 54-66 of Data Acquisition and Real-Time Systems. /Lawrence, D. E. (ed.). St. Lucia, Australia; Univ. of Queensland Press (1971).

From Seminar on data acquisition and real time systems; Canberra, Australia (9 Dec 1970).

Changes to the basic IBM 1800 TSX operating system are described which provide a convenient method of scheduling users' data analysis and data management problems and provide a highly flexible data acquisition system for low-energy nuclear physics experiments. Storage space allocation and data set modes are described. (Australia)

30483 DATA ACQUISTION AND CONTROL OF MASS SPECTROMETERS USED FOR ROCK AGE DETERMINATION. Arriens, P. A. (Australian National Univ., Canberra). pp 124-34 of Data Acquisition and Real-Time Systems. /Lawrence, D. E. (ed.). St. Lucia, Australia; Univ. of Queensland Press (1971).

From Seminar on data acquisition and real time systems; Canberra, Australia (9 Dec 1970).

A Hewlett–Packard 2116B computer is being interfaced with a series of mass spectrometers for data acquisition and computations in rock geochronology and isotopic geochemistry. (Australia)

30484 SOME ASPECTS OF ITALIAN LEGISLATION WITH REGARD TO THE ORGANIZATION OF RADIOLOGY AND NUCLEAR MEDICINE DEPARTMENTS IN HOSPITALS. Polvani, G. M. Minerva Med.; 61: 4452-6(6 Oct 1970). (In Italian).

The most peculiar and least known of the Italian legislation on the organization of radiology and nuclear medicine departments, and the radioprotection legislation (of which radiology and nuclear medicine constitute a particular application) are presented briefly. (J.S.R.)

Miscellaneous

30485 (ABCC-TR-8-70) DUPLICATION OF THE GALLBLADDER; A REPORT OF TWO CASES. Numaguchi, Yuji (Atomic Bomb Casualty Commission, Hiroshima (Japan). Atomic Bomb Casualty Commission, Nagasaki (Japan)). 26 Mar 1970. 11p. (In English and Japanese). Dep. NTIS.

30486 (ABCC-TR-14-71) SOLITARY CUTANEOUS CHROMOBLASTOMYCOSIS OF THE ELBOW. Case Report. Kirshbaum, Jack D. (Atomic Bomb Casualty Commission, Hiroshima

(Japan). Atomic Bomb Casualty Commission, Nagasaki (Japan)). [nd]. 9p. (In English and Japanese). Dep. NTIS.

30487 (ABCC-TR-35-70) GLUCOSE AND INSULIN RESPONSES AND INSULIN-GLUCOSE RATIOS FOLLOWING GLUCOSE CHALLENGE. Belsky, Joseph L.; Connor, Robert J.; Hall, William J.; Mandai, Tatsuo; Sadamasa, Shojiro (Atomic Bomb Casualty Commission, Hiroshima, Nagasaki (Japan)). [1970]. 25p. Dep. NTIS.

30488 (AECL-PAK/Lib-33) INCANDESCENT LAMPS. A Select Bibliography. Saleem, M. (Atomic Energy Centre, Lahore (Pakistan)). Aug 1971. 27p. Dep. NTIS (U. S. Sales Only).

30489 (ANL/BIM-72-1) TOTAL LINE SHAPE ANALYSIS OF DIGITIZED EXPERIMENTAL SPECTRA USING AN ITERATIVE NON-LINEAR LEAST SQUARES FITTING PROCEDURE. Kramer, Andrew P.; Angerman, Neil S.; Danyluk, Steven S. (Argonne National Lab., Ill.). Feb 1972. Contract W-31-109-eng-38. 73p. Dep. NTIS.

30490 (ANL/ES-10) COMPILATION OF THE AVERAGE DEPTHS OF LAKE MICHIGAN AND LAKE ONTARIO ON A TWO-MINUTE GRID. Hughes, T. H.; Birchfield, G. E.; Matthies, M. T. (Argonne National Lab., Ill.). Jan 1972. Contract W-31-109-eng-38. 94p. Dep. NTIS.

30491 (ANL/ES-CEN-1004) REDUCTION OF ATMOSPHERIC POLLUTION BY THE APPLICATION OF FLUIDIZED-BED COMBUSTION. Annual Report, July 1970-June 1971. Jonke, A. A.; Vogel, G. J.; Anastasia, L. J.; Jarry, R. L.; Ramaswami, D.; Haas, M.; Schoffstoll, C. B.; Pavlik, J. R.; Vargo, G. N.; Green, R. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 112p. Dep. NTIS.

30492 (ANU-P-533) UNIDENTIFIED LINES IN THE BEAM-FOIL SPECTRUM OF CARBON. Carriveau, G. W.; Doobov, M. H. (Australian National Univ., Canberra. Research School of Physical Sciences). [1971]. 4p. Dep. NTIS (U. S. Sales Only).

The beam-foil spectra of 685- and 1600-keV carbon ions were studied, using the Doppler-shift charge-assignment method. Of 57 spectral lines observed in the range 1800 to 6000 Å, 52 were assigned to transitions in C II to C V. Of the 5 unidentified lines, the charge states of the emitting ions were measured in two cases. (auth)

30493 (BDX-613-576) MACHINING MINIATURE SLOTS AND FILLETS. PDO 6984388, Final Report. Gillespie, L. K. (Bendix Corp., Kansas City, Mo.). Jan 1972. Contract AT(29-1)-613. 86p. Dep. NTIS.

30494 (BDX-613-667) FILAMENT WINDING INITIAL DEVELOPMENT. Korach, G. F.; Palmer, R. W. (Bendix Corp., Kansas City, Mo.). Mar 1969. Contract AT(29-1)-613. 96p. Dep. NTIS.

30495 (BNL-16531) SAMPLING PARTICULATES WITH ROTATING ARM IMPACTION SAMPLERS. Raynor, Gilbert S. (Brookhaven National Lab., Upton, N. Y.). [nd]. 27p. (CONF-720113-1). Dep. NTIS.

From first workshop conference on ecological systems approaches to aerobiology; Manhattan, Ks. (6 Jan 1972).

30496 (CALT-767-P-3-23) DAMPING OF DISLOCATION MOTION BY CONDUCTION ELECTRONS IN METALS. Jassby, K. M.; Shull, M. (California Inst. of Tech., Pasadena. W. M. Keck Lab. [of Engineering Materials]). [1972]. Contract AT(04-3)-767. 15p. Dep. NTIS.

30497 (CEA-CONF-1944) FAST IDENTIFICATION ALGORITHM AND ITS APPLICATION TO THE CHARACTERIZATION OF BIPOLAR TRANSISTORS. Bonnemay, Alain; Munoz, Antonio (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1971. 18p. (In French). (CONF-710543-2). Dep. NTIS (U. S. Sales Only).

From Conference on hybride automation and calculation; Cadarache, France (26 May 1971).

30498 (CONF-720208-1) VARIANT HEMOGLOBINS IN AGED ANIMALS. Popp, R. A. (Oak Ridge National Lab., Tenn.). [1972]. 11p. Dep. NTIS.

From second conference on embryonic and fetal antigens in cancer; Oak Ridge, Tn. (14 Feb 1972).

30499 (CONF-720313-1) LAND-USE CHANGE AND FOREST SUCCESSION MODELS. Hett, Joan M. (Oak Ridge National Lab., Tenn.). [1972]. 45p. Dep. NTIS.

From Symposium on forestry and forest genetics; Taipei, China (26 Mar 1972).

30500 (CONF-720317-1) RESPIRATORY INFECTIONS AND THE PATHOGENESIS OF LUNG CANCER. Nettesheim, P.; Schreiber, H.; Creasia, D. A.; Richter, C. B. (Oak Ridge National Lab., Tenn.). [1971]. 45p. Dep. NTIS.

From International symposium on carcinogenesis; Dusseldorf, Germany (21 Mar 1972).

30501 (CONF-720407-2) SOME COMPARISONS OF CONTINUOUS AND PULSED JETS FOR EXCAVATION. Bresee, J. C.; Cristy, G. A.; McClain, W. C. (Oak Ridge National Lab., Tenn.). [1972]. 20p. Dep. NTIS.

From International symposium on jet cutting technology; Coventry, England (5 Apr 1972).

30502 (CONF-720416-1) PARAMAGNETIC RESONANCE SPECTRA OF $^{3+}$Ti, $^{3+}$Fe, AND $^{2+}$Mn IN LUNAR PLAGIOCLASES. Weeks, R. A. (Oak Ridge National Lab., Tenn.). Mar 1972. 18p. Dep. NTIS.

From American Geophysical Society meeting; Washington, D. C. (17 Apr 1972).

30503 (CONF-720506-1) MORPHOLOGICAL STUDIES OF TRANSCRIPTION. Miller, O. L. Jr.; Bakken, Aimee H. (Oak Ridge National Lab., Tenn.). [1972]. 26p. Dep. NTIS.

From Karolinska symposium on gene transcription in reproductive tissue; Stockholm, Sweden (29 May 1972).

30504 (CONF-720509-1) WORK HARDENING THEORIES ANALYZED IN TERMS OF STORED ENERGY DATA. Wolfenden, A. (Oak Ridge National Lab., Tenn.). [1970]. 48p. Dep. NTIS.

From Symposium on defect interactions in solids; Bangalore, India (9 May 1972).

30505 (CONF-720602-1) DESIGN PARAMETERS FOR WATER JET TUNNELING MACHINES. Hahs, Charles Arthur (Oak Ridge National Lab., Tenn.). [1971]. 18p. Dep. NTIS.

From fourteenth symposium on rock mechanics; University Park, Pa. (12 Jun 1972).

30506 (COO-1198-874) ELECTRONIC TRANSITIONS AND THE HIGH PRESSURE CHEMISTRY AND PHYSICS OF SOLIDS. Drickamer, H. G.; Frank, C. W. (Illinois Univ., Urbana). [1971]. Contract AT(11-1)-1198. 341p. Dep. NTIS.

30507 (COO-1358-9) BIOACCUMULATION AND TRANSLOCATION OF RING-LABELED ^{36}Cl DDT IN AN OLD-FIELD ECOSYSTEM. Progress Report, September 1, 1970-August 31, 1971. Bandy, Le Roy W.; Peterle, Tony J. (Ohio State Univ., Columbus. Dept. of Zoology). Mar 1972. Contract AT(11-1)-1358. 241p. Dep. NTIS.

Thesis.

30508 (COO-2003-11) SILICA AND NITRATE DEPLETION AS RELATED TO RATE OF EUTROPHICATION IN LAKE MICHIGAN, LAKE HURON, AND LAKE SUPERIOR. Schelske, Claire L. (Michigan Univ., Ann Arbor. Great Lakes Research Div.). [1972]. Contract [AT(11-1)-2003]. 50p. Dep. NTIS.

30509 (COO-2037-8) LIQUID METALS RESEARCH. Technical Progress Report. (Ohio State Univ., Columbus. Dept. of Metallurgical Engineering). [15 Feb 1972]. Contract AT(11-1)-2037. 18p. Dep. NTIS.

30510 (COO-2037-12) PROPOSED ULTRAVIOLET BAND FILTERS. Olson, D. L.; Rigney, D. A. (Ohio State Univ., Columbus. Dept. of Metallurgical Engineering). [nd]. 15p. Dep. NTIS.

30511 (COO-3085-6) ISOENZYMES OF HEXOKINASE IN NORMAL AND NEOPLASTIC TISSUES OF THE RAT. Farron, Francoise (New England Deaconess Hospital, Boston, Mass. Cancer Research Inst.). [1972]. 8p. Dep. NTIS.

30512 (COO-3161-1) THEORETICAL PHONON PHYSICS. Progress Report, April 1, 1971-March 31, 1972. Krumhansl, J. A. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid

State Physics). Apr 1972. Contract AT(11-1)-3161. 12p. Dep. NTIS.

30513 (COO-3277-8) BINDING OF EDTA TO DEAE CELLULOSE AND ITS INTERFERENCE WITH PROTEIN DETERMINATIONS. Ward, William W.; Fastiggi, Richard J. (Johns Hopkins Univ., Baltimore, Md.). [1971]. Contract AT(11-1)-3277. 19p. Dep. NTIS.

30514 (COO-3420-1) CERAMIC RESEARCH ON TRANSFORMATIONAL SUPERPLASTICITY AND THE ELECTRON MICROSCOPY OF FERROELECTRIC DOMAIN BOUNDARIES. Research Progress Report, June 1, 1971–May 31, 1972. Bradt, Richard C.; Hoke, John H. (Pennsylvania State Univ., University Park. Dept. of Materials Science). 1 Mar 1972. Contract AT-(11-1)-3420. 18p. Dep. NTIS.

30515 (COO-3513-83) DIPHENYLTIN (IV) DICHLORIDE AS A MODEL COMPOUND IN MOESSBAUER SPECTROSCOPY. Herber, Rolfe H. (Rutgers Univ., New Brunswick, N. J.). [1971]. Contract AT(30-1)-3513. 17p. Dep. NTIS.

30516 (COO-3532-7) STUDY OF THE FINE STRUCTURE, BIOCHEMISTRY, AND CONTROL OF BACTERIAL SPOROGENESIS. Part I: Annual Report, January 1, 1971–December 31, 1971. Lundgren, Donald G. (Syracuse Univ., N. Y. Dept. of Biology). Contract AT(11-1)-3532. 62p. Dep. NTIS.

30517 (EUR-4780) COMPUTER CALCULATION FOR EMISSION SPECTROGRAPHIC ANALYSIS. Hecq, W. E.; Pel, D. J. (European Atomic Energy Community, Karlsruhe (West Germany). European Transuranium Inst.). 1972. 56p. (In French). Dep. NTIS (U. S. Sales Only). EUR FB 70,-.

30518 (EUR-4781) RADIATION HEMATOLOGY. Annual Report, 1970. Stich, W.; Thierfelder, St. (Gesellschaft fuer Strahlen- und Umweltforschung m,b,H., Munich (West Germany)). 1972. 38p. (In German). Dep. NTIS (U. S. Sales Only). EUR BF 60,-.

30519 (EUR-4789) GRAFI: A PACKAGE FOR PROGRAMMING THE IBM 2250 DISPLAY UNIT. Endrizzi, A. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center. European Atomic Energy Community, Ispra (Italy). European Scientific Data Processing Center). 7 Oct 1971. 18p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 40.-.

30520 (FRNC-TH-157) STUDY OF A RF ELECTRICAL DISCHARGE IN A STREAM OF AROMATIC HYDROCARBON VAPOR AT LOW PRESSURE. Le Goff, Felix (Rennes Univ. (France)). 1971. 139p. (In French). Dep. NTIS (U. S. Sales Only).
Thesis.

30521 (GKSS-71/E/10) ENERGY SUPPLY SYSTEM FOR COVERING POWER AND ENERGY REQUIREMENTS IN OCEANOLOGY. Benefeld, R.; Beushausen, J.; Victor, H.; Werner, G. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m,b,H., Hamburg (West Germany)). 1971. 323p. (In German). Dep. NTIS (U. S. Sales Only).

30522 (HMI-B-120) REPORT OF MEETING OF USER GROUP I OF SIEMENS PROCESS CALCULATORS, MAY 24–27, 1971, BERLIN. Abend, Peter; Bublitz, Renate (eds.) (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Mar 1972. 143p. (In German). Dep. NTIS (U. S. Sales Only).

30523 (IEA-201) CATECHOLAMINES: SYNTHESIS, METABOLISM, AND ACTIONS. Nicolau, Wilian; de Assis, Licio Marques (Instituto de Energia Atomica, Sao Paulo (Brazil)). Dec 1969. 45p. (In Portuguese). Dep. NTIS (U. S. Sales Only).
In Rev. Hosp. Clin., Fac. Med., Univ. Sao Paulo; 25: 105-22 (1970).

30524 (IEA-248) DYNAMICS OF POPULATIONS OF BIOMPHALARIA GLABRATA AND THE VON FOERSTER EQUATION. Coutinho, F. A. B.; Coutinho, A. B. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Oct 1971. 18p. Dep. NTIS (U. S. Sales Only).

30525 (IFVE-SVM-70-68) REALIZATION OF THE MODE OF DIRECT ADDRESSING TO THE MEMORY OF THE COMPUTER BESM-4. Matveev, V. D. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 25p. (In Russian). Dep. NTIS (U. S. Sales Only).

30526 (INP-774) ELECTRIC FIELD GRADIENTS IN VERY SMALL CRYSTALLINE PARTICLES. Hrynkiewicz, A. Z.; Pustowka, A. J.; Sawicka, B. D.; Sawicki, J. A. (Institute of Nuclear Physics, Krakow (Poland)). 1971. 9p. (CONF-710947-4). Dep. NTIS (U. S. Sales Only).
From fourth international conference of the socialist countries on Moessbauer spectrometry; Dresden, Germany (20 Sep 1971).

30527 (INP-784) CALORIMETRIC, DIELECTRIC, AND INFRA-RED INVESTIGATIONS OF SOLID t-BUTYL CHLORIDE. Urban, Stanislaw; Janik, Jerzy A.; Lenik, Janusz; Mayer, Jacek; Waluga, Tadeusz; Wrobel, Stanislaw (Institute of Nuclear Physics, Krakow (Poland)). Dec 1971. 35p. Dep. NTIS (U. S. Sales Only).

30528 (INR-1311) ION-MOLECULE REACTIONS IN ETHYL ALCOHOL. Michalska, Krystyna; Wincel, Henryk (Institute of Nuclear Research, Warsaw (Poland)). 1971. 18p. (In Polish). Dep. NTIS (U. S. Sales Only).

30529 (INR-1343) DEVICE FOR VERY RAPID COOLING OF METALS FROM LIQUID STATE. Chyczewski, M.; Matyja, H. (Institute of Nuclear Research, Warsaw (Poland)). 1971. 13p. (In Polish). Dep. NTIS (U. S. Sales Only).

30530 (INR-P-1340) ROLE OF THE ORGANIC PHASE IN EXTRACTION PROCESSES. Narbutt, Jerzy (Institute of Nuclear Research, Warsaw (Poland)). 1971. 13p. (CONF-700540-4). Dep. NTIS (U. S. Sales Only).
From Polish-Italian seminar on some chemical, ceramic, and metallurgical aspects of nuclear fuels; Zakopane, Poland (29 May 1970).

30531 (IPP-IV-33) PHOTOCHEMICAL IODINE LASER: INVESTIGATION OF THE KINETIC PARAMETERS FOR GIANT PULSE GENERATION. Hohla, K. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Dec 1971. 102p. (In German). Dep. NTIS (U. S. Sales Only).

30532 (IS-2562) FUTURE NUMERICAL ANALYSIS MAN–MACHINE INTERACTION. Keller, Roy F. (Iowa State Univ. of Science and Technology, Ames). [1970]. 10p. (CONF-700666-1). Dep. NTIS.
From American Society for Engineering Education Meeting; Columbus, Ohio (22 Jun 1970).

30533 (IS-2601) MAGNETIC TEMPERATURE SCALE FROM 0.9 TO 18K. Cetas, T. C.; Swenson, C. A. (Ames Lab., Iowa). [1971]. 44p. (CONF-710604-5). Dep. NTIS.
From fifth symposium on temperature; Washington, D. C. (21 Jun 1971).

30534 (IS-T-499) IRREVERSIBLE VOLUME CHANGES IN PRECIPITATION HARDENED COPPER–COBALT ALLOYS. Rehak, Dale Joseph (Ames Lab., Iowa). Apr 1972. Contract W-7405-eng-82. 98p. Dep. NTIS.
Thesis.

30535 (IS-T-502) INFRARED REFLECTIVITY OF CHROMIUM AND CHROMIUM–ALUMINUM ALLOYS. Lind, Michael Acton (Ames Lab., Iowa). Apr 1972. Contract W-7405-eng-82. 103p. Dep. NTIS.
Thesis.

30536 (IS-T-516) SILICONIZING STEEL IN MOLTEN MAGNESIUM ALLOY MEDIA. Usmani, Ziaul Haq (Ames Lab., Iowa). Apr 1972. Contract W-7405-eng-82. 83p. Dep. NTIS.
Thesis.

30537 (IS-T-517) KINETICS AND MECHANISMS OF SUBSTITUTION REACTIONS OF PENTACYANOFERRATES (III). Wolcnuk, Stephen Gregory (Ames Lab., Iowa). Apr 1972. Contract W-7405-eng-82. 65p. Dep. NTIS.
Thesis.

30538 (ITEF-855) PROGRAM POISK FOR RAZDAN-3 COMPUTER. Grishin, A. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreti-

cheskoi i Eksperimental'noi Fiziki). 1971. 28p. (In Russian). Dep. NTIS (U. S. Sales Only).

30539 (KAPL-M-7176) DATATRAN PRIMER. Kopp, H. J. (Knolls Atomic Power Lab., Schenectady, N. Y.). May 1971. Contract W-31-109-Eng-52. 34p. Dep. NTIS.

30540 (KFKI-72-2) THEORETICAL INVESTIGATION OF THE ELECTRONIC SPECTRA OF MONO-SUBSTITUTED BENZENE DERIVATIVES. Kiss, A. I.; Szoke, J. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Jan 1972. 15p. Dep. NTIS (U. S. Sales Only).

30541 (KURRI-TR-77) RESEARCH REPORTS FOR COOPERATIVE UTILIZATION FOR THE PERIOD OCTOBER 1967 TO MARCH 1968. (Kyoto Univ. (Japan). Research Reactor Inst.). 1970. 148p. (In Japanese). NTIS (U. S. Sales Only).

30542 (KURRI-TR-78) RESEARCH REPORTS FOR COOPERATIVE UTILIZATION FOR THE PERIOD OCTOBER 1968 TO MARCH 1969. (Kyoto Univ. (Japan). Research Reactor Inst.). 1970. 71p. (In Japanese). NTIS (U. S. Sales Only).

30543 (KURRI-TR-79) RESEARCH REPORTS FOR COOPERATIVE UTILIZATION FOR THE PERIOD APRIL 1969 TO SEPTEMBER 1969. (Kyoto Univ. (Japan). Research Reactor Inst.). 1970. 52p. (In Japanese). NTIS (U. S. Sales Only).

30544 (LA-4837) PHOTO-OXIDATION OF OLEFINS IN AIR SATURATED WITH HYDROGEN PEROXIDE VAPOR. Greiner, N. R. (Los Alamos Scientific Lab., N. Mex.). Feb 1972. Contract W-7405-eng-36. 4p. Dep. NTIS.

30545 (LA-4843) EFFECT OF TARGET THERMAL CONDUCTIVITY AND ROUGHNESS ON THE INITIATION OF PBX 9404 BY OBLIQUE IMPACT. Randolph, Alan D.; Hatler, L. E.; Popolato, A. (Los Alamos Scientific Lab., N. Mex.). Mar 1972. Contract W-7405-eng-36. 14p. Dep. NTIS.

30546 (LA-4846) 2DE: A TWO-DIMENSIONAL CONTINUOUS EULERIAN HYDRODYNAMIC CODE FOR COMPUTING MULTICOMPONENT REACTIVE HYDRODYNAMIC PROBLEMS. Kershner, James D.; Mader, Charles L. (Los Alamos Scientific Lab., N. Mex.). Mar 1972. Contract W-7405-eng-36. 40p. Dep. NTIS.

30547 (LA-4872) X-0242: A HIGH-ENERGY PLASTIC-BONDED EXPLOSIVE. Benziger, T. M. (Los Alamos Scientific Lab., N. Mex.). Feb 1972. Contract W-7405-eng-36. 3p. Dep. NTIS.

30548 (LA-4879) SYNERGY AND ARTIFICIAL INTELLIGENCE. Conant, Donald R. (Los Alamos Scientific Lab., N. Mex.). Mar 1972. Contract W-7405-eng-36. 31p. Dep. NTIS.

30549 (LA-DC-72-221) EXPERIMENTAL PERFORMANCE OF SUPERSONIC NOZZLES USING LITHIUM VAPOR AS A PROPELLANT. Roehling, D. J.; Stratton, T. F.; Fradkin, D. B. (Los Alamos Scientific Lab., N. Mex.). [nd]. 6p. (CONF-720405-1). Dep. NTIS.
From ninth electric propulsion conference; Bethesda, Md. (17 Apr 1972).

30550 (LA-tr-72-9) PROCESS FOR SOLDER-BRAZING TWO PIECES, OF WHICH AT LEAST ONE IS OF GRAPHITE. Lucien, Robert Guichet; Georges, Jacques Gotochian. Translated by Anna Vakar (Los Alamos Scientific Lab., N. Mex.), from French Patent 1,335,568. 4p. Dep. NTIS.

30551 (LBL-495) REACTIONS OF HEPTASULFUR IMIDE AND THE HEPTASULFUR IMIDE ANION. Mendelsohn, Marshall Harvey (California Univ., Livermore. Lawrence Livermore Lab.). Mar 1972. Contract W-7405-eng-48. 52p. Dep. NTIS. Thesis.

30552 (LBL-580) PICASSO: A GENERAL INTERACTIVE GRAPHICS MODELING PROGRAM. Austin, Donald M.; Holmes, Harvard H. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jan 1972. Contract W-7405-eng-48. 127p. Dep. NTIS.

30553 (LNF-71/75) ELECTRIC LOSSES IN CONDUCTORS AND SUPERCONDUCTORS EXCITED BY STEPWISE VOLTAGE. Del Vecchio, P.; Sacerdoti, G.; Veca, G. M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 17 Nov 1971. 44p. (In Italian). Dep. NTIS (U. S. Sales Only).

30554 (MHSMP-72-1) JOBSIM: A SCHEDULING FUNCTION. Frisby, John M. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex.). Sep 1971. Contract DA-11-173-AMC-487(A). 113p. Dep. NTIS.

30555 (MHSMP-72-25) MATHEMATICAL ANALYSIS OF HE DATA. Ashcraft, R. W.; Brown, J. M. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. Development Div.). Jul-Sep 1971. Contract DA-11-173-AMC-487(A). 8p. Dep. NTIS.

30556 (NASA-SP-5948(1)) ELECTRONIC SWITCHES AND CONTROL CIRCUITS. A Compilation. (National Aeronautics and Space Administration, Washington, D. C.). 1971. 21p. NTIS $1.00.

30557 (NP-19169) ANNUAL REPORT, 1970-1971. (Interuniversitair Reactor Instituut, Delft (Netherlands)). 72p. (In Dutch). Dep. NTIS (U. S. Sales Only).

30558 (NP-19242) INFRARED GENERATION BY COHERENT EXCITATION OF POLARITONS. Note No. 312. De Martini, F. (Rome Univ. (Italy). Istituto di Fisica). 14 Apr 1971. 75p. Dep. NTIS (U. S. Sales Only).

30559 (NYO-2471-49) DIELECTRIC RESPONSE OF SELECTED PARAELECTRIC IMPURITIES TO STRESS AND ELECTRIC FIELD PERTURBATIONS. Report No. 1684. Lewis, David Charles (Cornell Univ., Ithaca, N. Y. Materials Science Center). Sep 1971. Contract AT(11-1)-3152. 95p. Dep. NTIS. Thesis.

30560 (NYO-3661-40) ADSORPTION OF O-Ps ON SOLID SURFACES. Chuang, S. Y.; Tao, S. J.; Wilkenfeld, J. M. (New England Inst., Inc., Ridgefield, Conn.). Aug 1971. 5p. (CONF-710820-2). Dep. NTIS.
From International positron annihilation conference; Kingston, Ontario, Canada (31 Aug 1971).

30561 (ORNL-NSF-EP-15) ENERGY CONSUMPTION FOR TRANSPORTATION IN THE U. S. Hirst, Eric (Oak Ridge National Lab., Tenn.). Mar 1972. Contract W-7405-eng-26. 38p. Dep. NTIS.

30562 (ORNL-TM-3454) SUMMARY OF PRESENT STATUS FOR DESIGN AND ANALYSIS OF VACUUM DEAERATORS FOR DISTILLATION PLANTS. Eissenberg, D. M. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 34p. Dep. NTIS.

30563 (ORNL-TM-3714) INCIDENCE OF MAJOR DISEASES OF CONTROL, UNTREATED MOUSE STRAINS USED IN LIFE-SPAN STUDIES IN THE BIOLOGY DIVISION. Davis, M. L.; Cosgrove, G. E.; Walburg, H. E. Jr.; Leach, E. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 32p. Dep. NTIS.

30564 (ORNL-tr-2537) NATURE OF COMPETENT VIRAL PARTICLE CONTAINED IN STOCKS OF MOUSE SARCOMA VIRUS, MOLONEY ISOLATE. Guillemain, Bernard; Hampe, Annie; Boiron, Michel. Translated by R. Gregg Mainsfield (Oak Ridge National Lab., Tenn.), from Compt. Rend., Ser D; 269: 2283-6(1969). 7p. Dep. NTIS.

30565 (ORNL-tr-2582) DISTRIBUTION OF MERCURY. Stock, Alfred; Cucuel, Friedrich. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Naturwissenschaften; 22: 390-3(1934). 9p. Dep. NTIS.

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July 31, 1972. Bunt, John S. (Miami Univ., Fla. Rosenstiel School of Marine and Atmospheric Sciences). Contract AT(40-1)-3795. 75p. (UM-RSMAS-72023). Dep. NTIS.

30568 (ORO-4047-2) KINETIC, MAGNETIC, AND MOESSBAUER STUDIES ON PORPHYRIN SYSTEMS. Progress Report. Hambright, Peter (Howard Univ., Washington, D. C. Dept. of Chemistry). 15 Jan 1972. Contract AT(40-1)-4047. 11p. Dep. NTIS.

30569 (ORO-4061-2) RICE RESEARCH COMPUTER: A TAGGED ARCHITECTURE. Feustel, E. A. (Rice Univ., Houston, Tex. Lab. for Computer Science and Engineering). 5 Jan 1972. Contracts AT(40-1)-2572; AT(40-1)-4061. 38p. (CONF-720501-1). Dep. NTIS.
From Spring joint computer conference; Atlantic City, N. J. (16 May 1972).

30570 (PTB-JB-2/72) SUMMARY OF MINUTES OF MEETINGS OF THE PLENARY AS WELL AS THE COMPLETE PROCEEDINGS FROM 1869 TO 1970. Stenzel, Rudolf (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). Jan 1972. 70p. (In German). Dep. NTIS (U. S. Sales Only).

30571 (PUB/CAT-1972) INTERNATIONAL ATOMIC ENERGY AGENCY PUBLICATIONS, CATALOGUE 1972. (International Atomic Energy Agency, Vienna (Austria)). 1972. 173p. UNIPUB, New York.

30572 (RFP-1803) EVALUATION OF NUMERICALLY CONTROLLED MACHINE-TOOL DYNAMIC ACCURACY WITH LASER INTERFEROMETER. Utley, L. William (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 23 Mar 1972. Contract AT-(29-1)-1106. 6p. Dep. NTIS.

30573 (RLO-1750-45) DISTRIBUTION AND ECOLOGY OF OCEANIC ANIMALS OFF OREGON. Pearcy, William G. (Oregon State Univ., Corvallis. Dept. of Oceanography). [1968]. 45p. Dep. NTIS.

30574 (RLO-2221-T-4-7) NMR OF $^{17}OH_2$ IN AQUEOUS MANGANESE(II) SOLUTIONS. Lo, G. Y-S; Hunt, John P.; Dodgen, Harold W. (Washington State Univ., Pullman. Dept. of Chemistry). [1971]. Contract AT(45-1)-2221. 12p. Dep. NTIS.

30575 (RLO-2221-T-6-12) PARAMAGNETIC SUSCEPTIBILITY. Karlow, E. A.; Gruber, J. B. (Washington State Univ., Pullman. Dept. of Physics). 3 Jan 1972. Contract AT(45-1)-2221. 54p. Dep. NTIS.

30576 (SC-CR-715134) SYNTHESIS OF DIFLUORAMINO-POLYNITROAROMATIC COMPOUNDS USING ELEMENTAL FLUORINE: 3-DIFLUORAMINO-2,2',4,4',6,6'-HEXANITROSTILBENE. Lerom, Michael W.; Peters, Howard M.; Ross, Donald L.; Hill, Marion E. (Stanford Research Inst., Menlo Park, Calif.). [1971]. 20p. Dep. NTIS.

30577 (SC-DC-69-1771) MATHEMATICAL MODEL FOR SILICON-CONTROLLED RECTIFIERS. Harstad, D. N. (Sandia Labs., Albuquerque, N. Mex.). Jun 1969. 15p. Dep. NTIS.

30578 (SC-DC-721149) DETONATION WAVE SHAPING. Benedick, W. B. (Sandia Labs., Albuquerque, N. Mex.). [1972]. 27p. (CONF-720303-4). Dep. NTIS.
From twelfth annual symposium of the ASME; Albuquerque, N. Mex. (2 Mar 1972).

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From twelfth annual symposium of the ASME; Albuquerque, N. Mex. (2 Mar 1972).

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From twelfth annual symposium of the ASME; Albuquerque, N. Mex. (2 Mar 1972).

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30591 (SC-TM-720139) CIRCUIT RESISTANCE OF PERMANENTLY MATED ITEMS. Teresi, Joseph A. (Sandia Labs., Albuquerque, N. Mex.). Mar 1972. 10p. Dep. NTIS.

30592 (SCL-DC-70-260) FILAMENT WOUND MATERIALS EVALUATION WITH ACOUSTIC EMISSION. Rathbun, D. K.; Beattie, A. G.; Hiles, L. A. (Sandia Labs., [Livermore, Calif.]). Apr 1971. Contract AT(29-1)-789. 32p. (CONF-710454-1). Dep. NTIS.
From eighth symposium of nondestructive evaluation; San Antonio, Tx. (22 Apr 1971).

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Los Angeles, Calif.). Feb 1972. Contract W-7405-eng-26; Subcontract 3354. 84p. Dep. NTIS.

30597 (TRG-Report-2163) LIQUID FLOW PROPORTIONAL SAMPLERS. Jennison, W. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). 1972. 40p. Dep. NTIS (U. S. Sales Only).

30598 (TUBIK-24) ANNUAL REPORT, 1970. (Technische Universitaet, Berlin (West Germany). Institut fuer Kerntechnik). Dec 1971. 18p. (In German). Dep. NTIS (U. S. Sales Only).

30599 (UCID-30030) INTRODUCTION TO THE TMDS. Keller, Peter R. (California Univ., Livermore. Lawrence Livermore Lab.). 15 Mar 1972. Contract W-7405-eng-48. 21p. Dep. NTIS.

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30602 (UCLA-12-857) PREDICTIVE MODEL FOR MOJAVE DESERT ECOSYSTEMS. Beatley, Janice C. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [1972]. Contract AT(04-1)-Gen-12. 21p. Dep. NTIS.

30603 (UCRL-20256(Pt.1)) CURRENT REFERENCE MATERIALS FOR THE PHYSICAL SCIENCES. Kingsbury, Raphaella (California Univ., Berkeley. Lawrence Radiation Lab.). Jan 1971. Contract W-7405-eng-48. 12p. Dep. NTIS.

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30605 (UCRL-73357) NUCLEAR CHEMICAL MINING OF PRIMARY SULFIDE ORES. Lewis, A. E.; Braun, R. L.; Higgins, G. H. (California Univ., Livermore. Lawrence Radiation Lab.). Oct 1971. 11p. (CONF-720507-1). Dep. NTIS.
From AIME and Japanese Metallurgical Society joint meeting; Tokyo, Japan (May 1972).

30606 (UCRL-73577) PRACTICAL SOLUTION TO THE THERMAL STABILITY PROBLEM IN MACHINE TOOLS. Bryan, J. B.; Donaldson, R. R.; McClure, E. R.; Clouser, R. R. (California Univ., Livermore. Lawrence Livermore Lab.). 1 Dec 1971. 26p. (CONF-720406-2). Dep. NTIS.
From International engineering conference and tool exposition; Chicago, Il. (24 Apr 1972).

30607 (UJV-2776-Ch) ACTIVITY OF METHYL IODIDE VAPOR AND ITS NON-IDEAL BEHAVIOR NEAR NORMAL PRESSURE AND TEMPERATURE. Cejnar, F. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1972. 11p. (In Czech). Dep. NTIS (U. S. Sales Only).

30608 (UR-49-1497) FLUORIDE-CONTAINING METABOLITES AFTER METHOXYFLURANE ANESTHESIA. Fry, Bill W.; Taves, Donald R. (Rochester Univ., N. Y. School of Medicine and Dentistry). [1971]. 13p. (CONF-710837-1). Dep. NTIS.
From second conference on environmental toxicology; Dayton, OH (31 Aug 1971).

30609 (UR-3055-3) CRYSTAL STRUCTURE OF $Mn_2P_2O_7.2H_2O$. Schneider, Stephen F. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). 1972. 40p. Dep. NTIS.
Thesis.

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30611 (UR-3490-90) METABOLIC RESPONSE TO GROWTH HORMONE ADMINISTRATION, WITH PARTICULAR REFERENCE TO THE OCCURRENCE OF HYPERCALCURIA. Bryson, Michael F.; Forbes, Gilbert B.; Amirhakimi, G. H.; Reina, Julio C. (Rochester Univ., N. Y.). [1971]. 30p. Dep. NTIS.

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Thesis.

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30615 (UR-3490-106) CRYSTAL STRUCTURE OF SILVER DIETHYL PHOSPHATE, $AgPO_2(OC_2H_5)_2$. Hazel, J. P.; Collin, R. L. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). [1972]. 23p. Dep. NTIS.

30616 (WAPD-T-2438) TWO-PHASE TURBULENT MIXING MODEL FOR FLOW IN ROD BUNDLES. Beus, S. G. (Bettis Atomic Power Lab., Pittsburgh, Pa.). [1970]. Contract AT-11-1-GEN-14. 37p. (CONF-711112-6). Dep. NTIS.
From Annual meeting of American Society of Mechanical Engineers; Washington, D. C. (28 Nov 1971).

30617 (Y-1803) CARBON-FIBER THERMAL INSULATION. Ardary, Z. L.; Reynolds, C. D. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 9 Mar 1972. Contract W-7405-eng-26. 43p. Dep. NTIS.

30618 BIBLIOGRAPHY OF CONGRESSIONAL PUBLICATIONS ON ENERGY FROM THE 89th CONGRESS TO JULY 1, 1971. COMMITTEE ON INTERIOR AND INSULAR AFFAIRS, UNITED STATES SENATE, 92 CONGRESS, 1st SESSION, PURSUANT TO S. RESEARCH 45, A NATIONAL FUELS AND ENERGY POLICY STUDY, SERIAL NO. 92-6. Washington, D. C.; Joint Committee on Atomic Energy (1971). 59p.

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